Rocking in the Yukon

An overview of mining in the Yukon

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Yukon
Economic Development

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Cover photo: Geologist Julie Hunt collecting geological information during fieldwork.

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INTRODUCTION

The end products from local and global mining of minerals are an important part of our everyday lives. Examples can be found in our homes: the convenience of copper wiring that allows us to turn on the lights, gypsum in wall board and gold and silver in computers. Our vehicles rely on lead in batteries and zinc in car bodies.

Many mining products also have an extended life through modern recycling technology. The smelters for newly mined and recycled minerals rely on coal as the major source of power, another product of mining. Our modern lifestyles are more connected to the mining industry than many of us realize.

This booklet provides an overview of mining and mineral resources in the Yukon. We hope it provides you with a good understanding of the importance of our mining industry and the benefits it provides to many Yukon people.

The Yukon Geology Program staff, shown above, provide key support for the development of mining in the Yukon. From left to right (top) Craig Hart, Anna Fonseca, Eric Peterson, (bottom) Robert Deklerk, Charlie Roots, Tammy Allen, Mike Burke, Don Murphy, Grant Lowey, Lee Pigage, Ken Galambos, Leyla Weston, Jeff Bond, Panya Lipovsky, Jo-anne vanRanden, Bill LeBarge, Julie Hunt, Ali Wagner, Maurice Colpron, Danièle Héon, Monique Raitchey, Grant Abbott, Shirley Abercrombie, Gary Stronghill, Diane Emond and Gord Nevin.

YUKON FACTS: SETTING THE STAGE

Population
30,553 (December 2000)

Area
483,450 square kilometres
(4.8% of Canada's total land area)

Major sectors
government, tourism, mining

Real GDP by industry
$970.5 million (1999, in 1992 dollars)

Value of mineral production
$61,756 million (1999)

Mineral exploration expenditures
$8.8 million (2000)

Mineral development expenditures
$550,000 (1999)

Fur production
$300,000 (estimate 2000)

Primary forest production
323,500 cubic metres (1997-1998)

Tourism: Tourism is measured by non-resident highway border crossings into the territory. There were a total of 263,000 people crossing the border into the territory in 2000.

Retail trade
$344 million (2000)

Value of real estate transactions
$99.8 million (2000)

Average house selling price
$143,800
(Whitehorse, quarter 4, 2000)

Median rental rates
1 bedroom $623/month
2 bedrooms $675/month
(Whitehorse, December 2000)

Commercial lot price
$34 per square foot
(Whitehorse, October 1999)

Residential power rate
first 1,000 kilowatt hours,
9.86 cents per kWh
over 1,000 kilowatt hours,
10.45 cents per kWh
(March 2001)

General service power rate
first 2,000 kilowatt hours,
8.31 cents per kWh
over 2,000 kilowatt hours,
10.45 cents per kWh
(March 2001)

Minimum wage
$7.20/hour (April 2001)

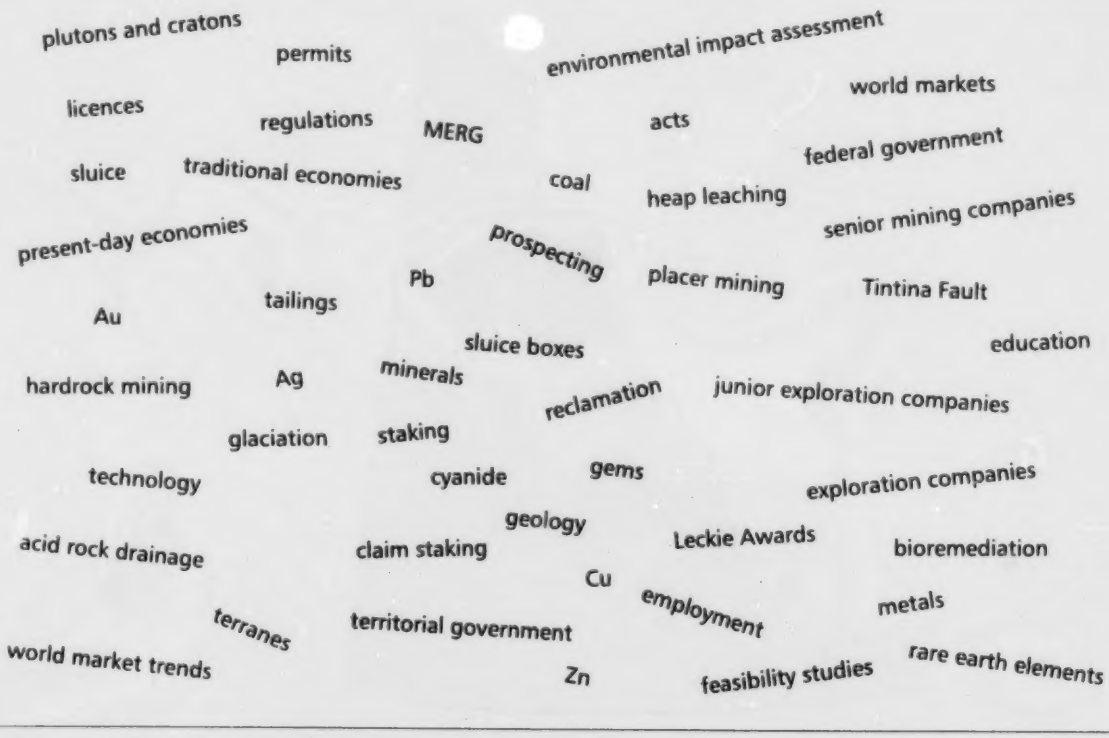
Average weekly earnings
$702.98 (June 2000)

Property tax rate
residential, 1.254% of assessed value
non-residential, 1.387% of assessed value
agricultural, 1.164% of assessed value
(Whitehorse, 2001)

Corporate taxes
15% of taxable income
2.5% for manufacturing companies
6% for small business
(2001)

Personal income tax rate
46% of basic federal tax rate
(2001)

Sales tax
7% federal goods and services tax
no territorial sales tax



Here are some of the mining terms you will become familiar with in this overview. A glossary on page 56 defines many of them.

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ECONOMIES: UNIQUE RESOURCES

Mineral exploration and production have been the most significant non-government economic forces in the Yukon for over 100 years. The mining sector has accounted for as much as 28 per cent of the Yukon's Gross Domestic Product (GDP). For this reason, much of the Yukon's infrastructure, support services and skilled workforce has been geared towards supporting the mining industry.

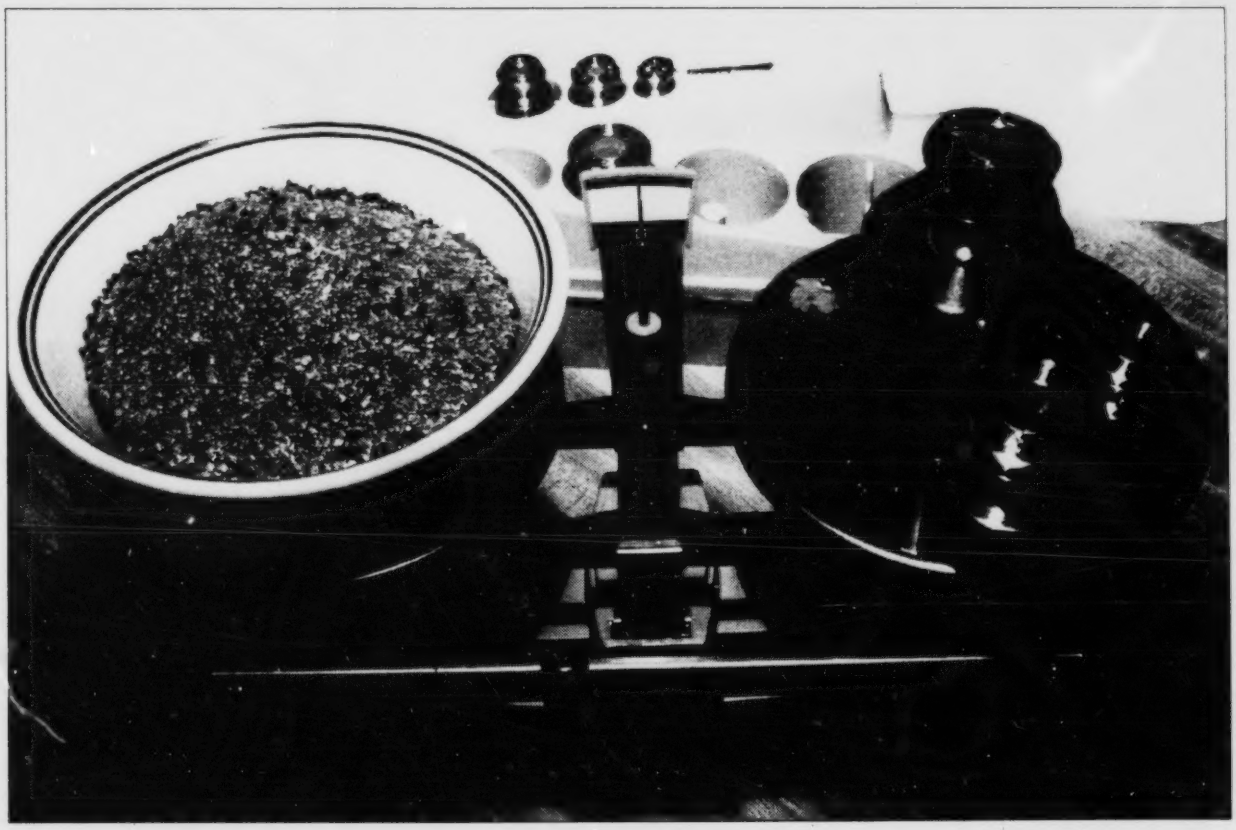
According to Industry Canada, between 1993 and 1998, the runaway leaders of Yukon products exported to the world were zinc and lead concentrates. In 1996, when the Faro lead-zinc mine was in full operation, production from Yukon mines accounted for 2.1 per cent of total world zinc production and 3.2 per cent of total world lead production. For a small economy, the Yukon has made a relatively significant contribution to global lead and zinc production.

The giant lead-zinc mine at Faro, when fully operational, was also a significant contributor to the local Yukon economy representing an estimated 12 to 15 per cent of the Yukon's Gross Domestic Product, and an estimated 70 to 85 per cent of the Yukon's mineral production. However, the Faro mine ceased production in 1998.

There is currently one operating hardrock mine: Viceroy Resource Corporation's Brewery Creek gold mine. Production for 2000 was projected to be about 50,000 ounces of gold.

There are currently 64 active placer mines.

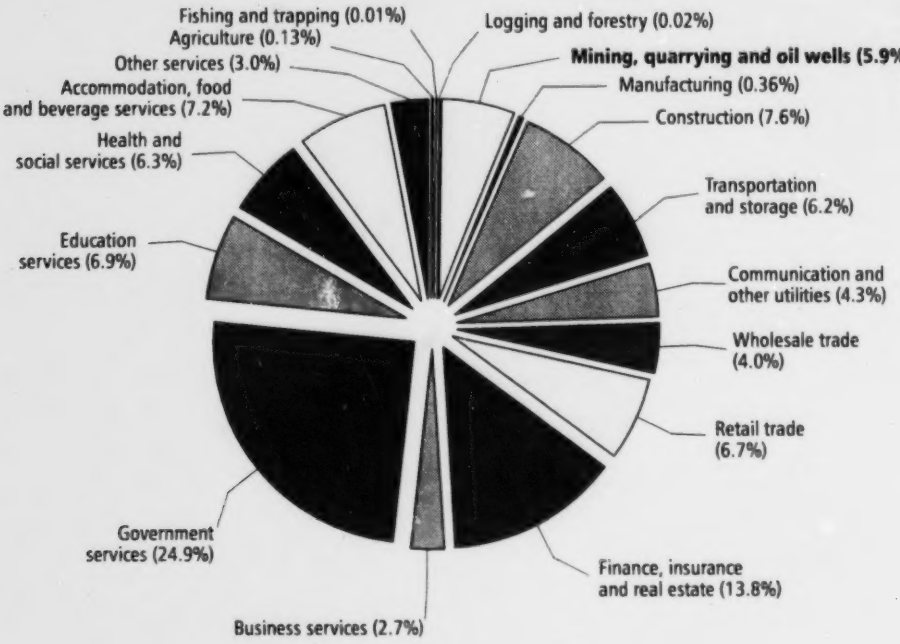
Exploration expenditures for 2000 were estimated to be $8.8 million, down from $9.5 million spent in 1999. This is a reflection of poor commodity prices and the lack of speculative investors.



Yukon government

Weighing gold with a scale, at the Bleiler placer mine.

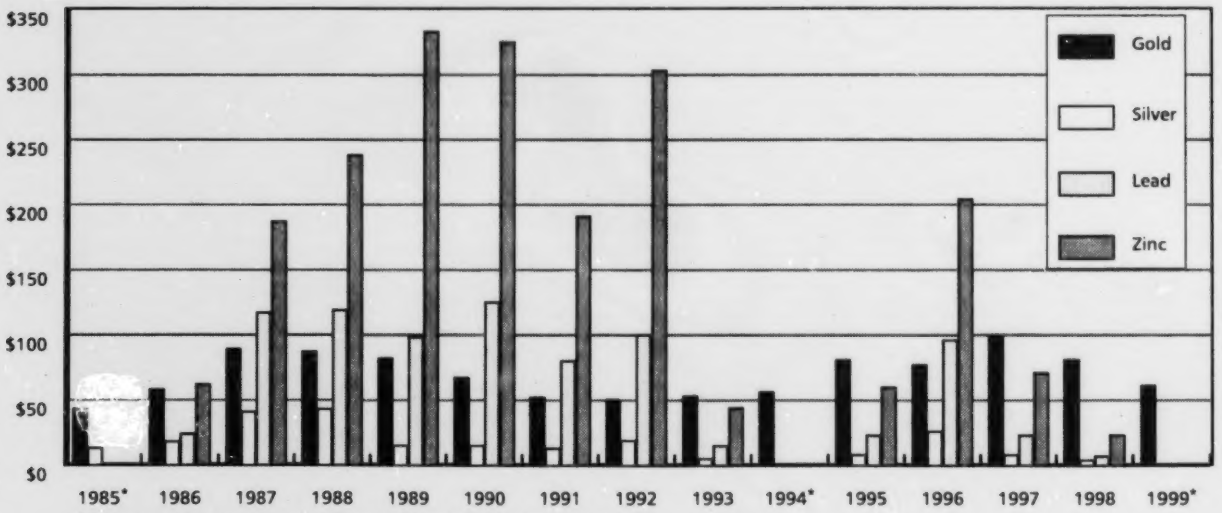
YUKON GROSS DOMESTIC PRODUCT, BY INDUSTRY, 1999



Yukon Bureau of Statistics

Exploration in 2000 was divided equally between the search for base metals, such as lead and zinc, and precious metals, such as gold and silver. Gold exploration was focused on gold deposits within the Tintina gold belt. (See map, page 16.) Base metals exploration was rekindled in the Finlayson Lake area, resulting in a positive pre-feasibility study. (See maps, page 17.)

VALUE OF MINERAL PRODUCTION IN THE YUKON



*No lead or zinc production due to the shutdown of the mine in Faro.

Yukon Bureau of Statistics

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WORLD GOLD PRICE AND VALUE OF GOLD PRODUCTION IN THE YUKON

UP AND DOWN: WHY?

Mining, like any other business, is driven by a combination of supply and demand. The need for the metal-based products that we use every day drives the demand for raw and finished metal products.

The location and quantity of mineral-rich deposits depend on geological factors. The best find is near-surface rock with a high content of minerals (high grade). It is more expensive to extract minerals when they are less concentrated or low content (low grade). However, global economic conditions impact where the extracted minerals will come from, where they will be processed, how much they are worth, and who will make a profit. For example, a low-grade deposit may become economically feasible to mine as demand increases. The mining and metal industries, like many other businesses, are highly competitive at a world level.

Global factors, such as the price of metals, directly affect the profitability of a mine. If the mining company cannot sell its product for a profit, it will stop producing until global factors change. Over the years, the law of supply and demand has created a cycle of ups and downs in the Yukon and the worldwide mining industry.

In some cases, political events around the world affect the supply of a particular mineral. For example, when China released tonnes of tungsten on the market in the 1980s, the price decreased significantly. Many mines, including the Cantung mine north of Watson Lake, could not compete with this cheaply produced ore and had to close. The Chinese reserves are decreasing and, as a result, the price of tungsten is slowly rising. One day, it may reach the threshold that makes the Cantung mine profitable and allow it to re-open.

The investment climate is driven by the possibility of financial return. Many factors affect the attractiveness of a country at a given time. Political instability can add risk. The lack of skilled labour, infrastructure, or access to resources can add cost to mineral resource extraction.

Exploration activity also follows this supply and demand cycle and is subject to the conditions of the investment climate. However, the abundance of significant mineral deposits in the Yukon ensures that there will be a continuing interest in our resources.

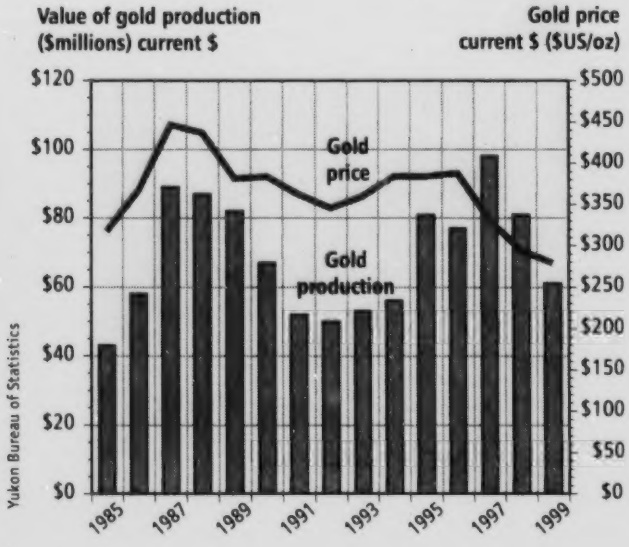
Providing power for industry

Aishihik Lake, the only multi-year reservoir on the Whitehorse-Aishihik-Faro power grid system, was built in the late 1970s to provide affordable electricity to large mining projects. This power source makes residential, industrial and commercial development possible. As a result, it significantly reduces Whitehorse's dependence on diesel power in winter. Diesel power is more expensive and has a greater impact on the environment.

ECONOMIES OF SCALE

The Yukon still has potential for the discovery of near-surface, world class mineral deposits. However, exploration trends in the Yukon seem to indicate that smaller deposits with shorter life-spans will be more common — much like the mines developed since the 1980s at Mount Skukum, Ketza River, Brewery Creek, Sa Dena Hes and Mount Nansen. (See the map, page 21.) Currently, almost all Yukon exploration projects in the advanced permitting stages fall into this "short mine life" category. Even the largest of these projects are considering mines with an expected life of 10 to 12 years. These mines require much smaller capital investment and therefore may be easier to finance.

WORLD GOLD PRICE AND VALUE OF GOLD PRODUCTION IN THE YUKON



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Skagway remains key to Yukon mining success

Located only 160 kilometres from Whitehorse by an all-weather road, the port of Skagway is a deep-water, ice-free, year-round Alaskan port. Facilities include a 10,000-square-metre ore concentrate storage warehouse and 100,000 square metres of open storage. It has been designed and equipped to handle outbound ore concentrates from Yukon mines. Water depth is 12.8 metres at the dock face, and the docks are commonly used by large ore transport ships. The port of Skagway is 760 kilometres closer to Japan than is the port of Vancouver.

NEW TECHNOLOGY

Mining has become increasingly efficient, and new technologies have now made lower grade deposits economically viable. Increased process efficiency and streamlining, combined with the economies of scale, have made large volume mining viable in short time periods. These changes are reflected in the metal prices on the stock market. The prices show consistent downward trends. This is not due to reduction in value, but reflects the competitive nature of mining at consistently lower prices.

EMPLOYMENT

Despite its cyclical nature, the mining industry is still key to the Yukon economy. Although exact figures are difficult to find, it is generally agreed that, in good mining years, hardrock mines employ more than 1,000 people and placer mines employ 600 to 700 people. In a territory of about 30,500 people, this direct employment from mining has an important economic impact. These figures do not include others who are involved in mineral exploration such as prospectors, geologists, surveyors and construction workers.

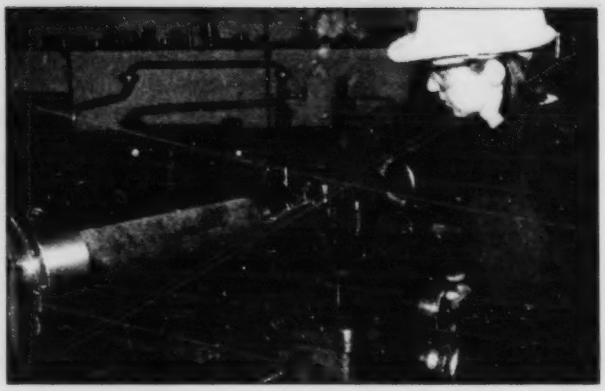
The economic impact of mining extends well beyond those who work at the mines or those who are looking for new mines. Economists refer to this impact as a "multiplier" and multiply the number of jobs in a sector to derive the total impact on a region. In the Yukon, one and a half is the multiplier for the mining industry. This means that for every person employed in mining, an additional half job is created elsewhere in the economy.

THE "MULITPLIER EFFECT" Examples of goods and services

- Accommodation
- Air support
- Air transportation
- Aircraft charter
- Airfreight
- Airstrip management
- Architectural services
- Assay services
- Automotive supplies
- Baking
- Banking services
- Bearings and seals
- Belts, liners and fasteners
- Boilers
- Building supplies
- Bus and taxi services
- Clothing
- Compressors and spares
- Computers and computer supplies
- Concentrate handling
- Cooking and catering
- Core boxes and storage racks
- Crushing and grinding
- Diesel oil
- Drill steel and bits
- Drilling contractors
- Dust collectors
- Electrical supplies
- Electronic appliances
- Engineering services
- Engines (gas and diesel)
- Environmental services
- Expediting services
- Explosives
- Fans and blowers
- Filters and cloth
- Fire fighting equipment
- Furniture
- General contractors
- Generators
- Geochemical services
- Groceries
- Heating systems
- Hoses, tubes and fittings
- Lumber and timber
- Medical supplies
- Office services
- Office supplies
- Paint
- Pilot services
- Reagents and supplies
- Repairs and replacement parts for machinery and vehicles
- Rescue and safety equipment
- Road maintenance
- Shelving
- Storage sheds
- Telephones and communications
- Tools
- Water treatment

Money spent on mineral exploration flows to local businesses

Studies in other jurisdictions demonstrate the positive economic impact of mineral exploration. Manitoba reports that every dollar spent by government through its mineral incentive program generates nearly $5 in mineral expenditures, plus an additional $2 in business income. In Alaska, at least 65 per cent of $35 million in certified exploration expenditures flows directly to local businesses.

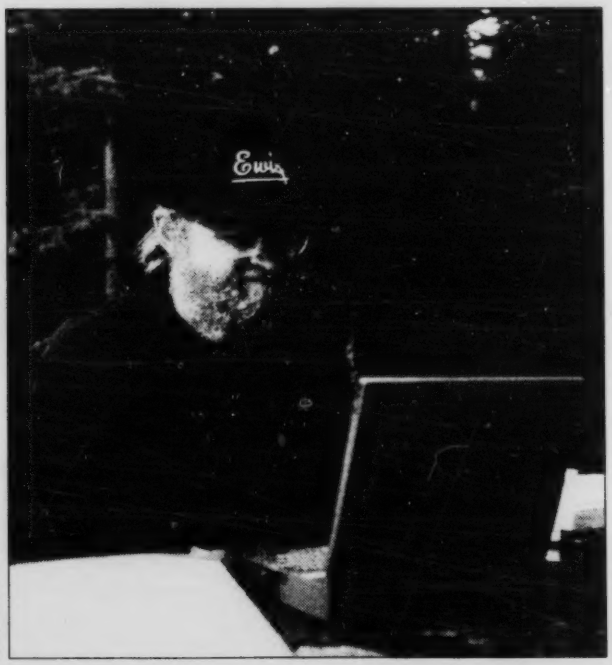


Yukon government

A tinsmith apprentice, Advanced Education.

In areas where secondary processing of ore occurs, or additional value is added through the manufacturing of finished products, the multiplier effect is larger.

Most Yukon communities are affected by the economic activity that results from the mining industry. Most of the Yukon's main highways, with the exception of the Alaska Highway, were developed because of mining projects. These roads are now access routes for many tourist and recreational destinations. They keep goods, services and people circulating easily between communities.



Danièle Héon

Geologist Don Murphy, Yukon Geology Program, entering data in the field.

Work opportunities

Images of a mine worker with pick and shovel in hand no longer apply to the changing mining workplace of today and tomorrow. A modern mine worker needs training in mathematics and computer technology. New technologies have become an integral part of the mining industry. One example is the use of global positioning systems (GPS) to fix the location of soil, silt and rock samples collected during an exploration program. This information is then entered into a Geographic Information System (GIS). A GIS is a system of hardware, software and personnel used for the storage, retrieval, mapping and analysis of the geographic data created from this field information. With GIS, data analysis becomes more efficient compared to the manual methods of the past. Mining companies can analyze, create and present digital maps with multi-dimensional layers and information from their field and drilling data.

Mining offers a variety of job opportunities for Yukoners. Each stage in the mining process opens the door for local employment. Staking a claim or cutting line requires people experienced with bush survival and the ability to stay in remote camps for extended periods of time. First aid, map reading and compass skills are also important. It is necessary to be in good physical condition.

Prospecting skills, acquired through years in the field, are still very important to mining companies which rely on seasoned prospectors to discover new mineral showings. Prospectors bring their own expertise and insight to a company's search for a resource.

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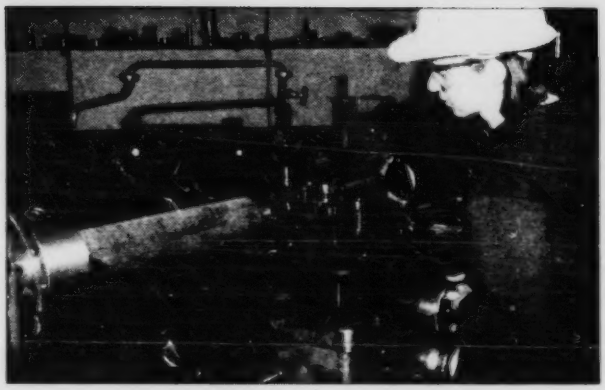

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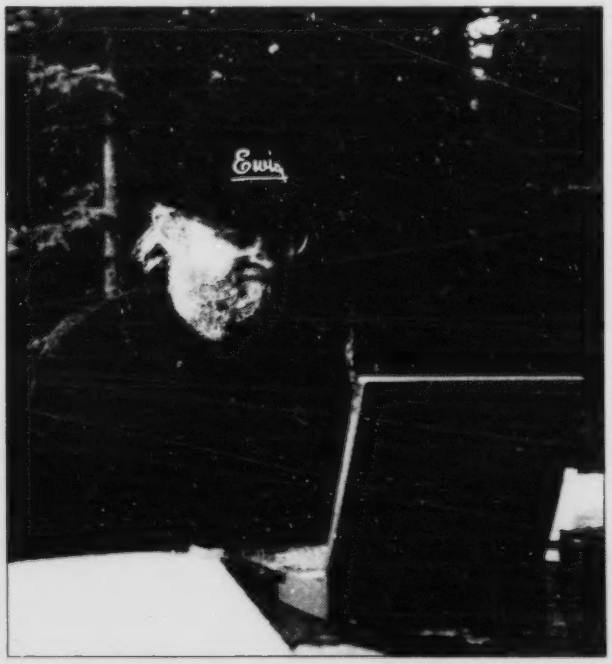

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Camp cooks play a key role in any exploration program and for this reason they are usually well paid. If you have a bad cook, you have a problem!

If exploration reveals a potential mineral-rich deposit, the exploration company will hire surveyors to ensure that claims are in order and properly staked.

Once significant mineral resources have been confirmed, baseline environmental data will be collected. Biologists will identify what flora and fauna are in the area and study local ecosystems. Baseline information on creek water, such as pH, naturally occurring metals, sediment levels, and benthic invertebrate populations will be determined through a water-sampling program. Water quality, fish habitat and populations will be inventoried.

Once this data is established, the condition of the environment can be monitored. Environmental assessment and monitoring are becoming a more important component of mining.

Engineering firms design mines, test the construction designs, monitor the environmental impacts and plan for the reclamation of the site to a more natural state.

During the building and production phases, a variety of tradespeople are required including electricians, carpenters, millwrights, heating and ventilation technicians, truck drivers and backhoe operators.

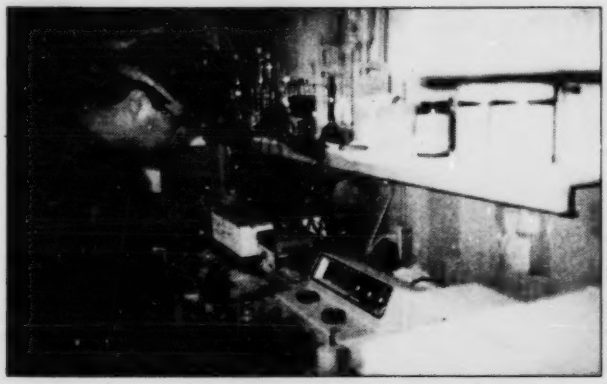
Mills require system control people who can deal with the monitoring and automated equipment in a modern-day mill.

Many more Yukon people running their own businesses serve the mining industry. Construction companies are directly involved in building mills, roads, dams and dikes for mine sites. As with any large business, accountants, lawyers and clerical and secretarial services are required.

Even after a mine shuts down, environmental technicians and engineers must complete monitoring and carry out reclamation work to prevent soil erosion and encourage

Rock-on Yukon grade 5 curriculum, Yukon Chamber of Mines

Some employment opportunities available in the mining industry.



Allan Carlick, DIAND

Lab analysis at Brewery Creek.

the area to return to a natural state. Companies often hire contractors to carry out many of these jobs.

Training opportunities

Mining companies may develop socio-economic agreements with Yukon First Nations. These agreements include training and employment opportunities.

At different times, Yukon College offers programs for entry-level mine training, including courses in industrial safety, tools, first aid, hydraulics, heavy equipment maintenance and welding. The majority of graduates find work. These college programs are often client-driven, tailored to different operations and communities. Residents of the community receive enrolment priority.

Often there is a hands-on component at the mine site. In the past, Carmacks-based sessions were held at BYG's Mount Nansen mine where the students learned how to use and maintain the company's equipment. This has also been done at Viceroy's Brewery Creek mine.

Rod Hill

Geologists looking at rock cores.

Yukon government

Mining exploration crew member greasing the ends of a drill rod.

One Whitehorse session continued an extra six weeks after Golden Hill Ventures lent its equipment to the program for practical training.

There are opportunities for students and aspiring geologists to work with exploration geologists during the summer. The scientists in the Yukon Geology Program often hire student assistants.

Yukon people are sometimes hired on as helpers. For example, diamond drillers are still trained on the job.

The Yukon Chamber of Mines offers annual introductory and advanced courses in prospecting. These courses are recommended for people applying for funding through the Yukon Mining Incentives Program. A Mine Training Trust Fund, administered by an independent board set up by the Yukon Chamber of Mines, has been created to ensure that both Yukon people and mining companies benefit from a trained local labour force.

IMPORTANT MINERAL RESOURCES
Traditional economies

Metal and mineral resources have always had cultural significance for Yukon First Nations people. The values placed on these resources were different from the values of present-day society. Valued resources among First Nations were traded over great distances. These long-established trading practices were highly sophisticated.

Copper

Copper, a highly valued metal of Yukon First Nations, was rarely discarded. Nuggets were collected from the gravels of the White River, Sheep Creek and Bullion Creek by the Southern Tutchone who held the trade monopoly on copper from this region. The nuggets were hammered into thin, flat sheets and cut into desired shapes. Copper sheets were then stacked into layers and hammered together to make highly valued larger pieces. Copper had many uses in Yukon First Nation societies. Knife blades, prongs, hooks, gaffs, awls, arrow points and tubular beads were but a few uses. Copper is still believed to have healing powers.

Obsidian

Natural glass was collected from outcrops and stream beds in the eastern ranges of present-day Kluane National Park. However, many Yukon First Nations also

Yukon government

Copper sculpture at the Beringia Centre, Whitehorse, Yukon. Artists: Mark Porter, Brian Walker, Keith Wolfe-Smarch

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obtained obsidian from Mt. Edziza, near the Stikine River in northern British Columbia. The Mt. Edziza sources were controlled by the First Nations of the area and traded extensively with Yukon First Nations for over 6,000 years. Chunks of obsidian were fractured and shaped into sharp cutting edges, stronger and more perfect than steel.

Red ochre (hematite)

This iron ore was valued as a pigment. Though iron ores are found extensively in the Yukon, very few sources were satisfactory as ochre. An important source of ochre was at Paint Mountain, just east of present-day Haines Junction. Red pigment stones were baked, crushed and pulverized into powder for use on the face and clothing, or for rock paintings.

Iron

There were no local sources of iron. Iron was acquired by Yukon First Nations through trading and was valued for its uses.

Gold

Traditionally, gold was not considered of economic value to Yukon First Nations. Copper held greater cultural value than gold. Gold nuggets found in stream beds were often discarded. Knowledge of stream beds containing gold was quite extensive among Yukon First Nations of the area.

Angela Sidney describes how her uncle, Skookum Jim, while searching for his two sisters, was involved in staking the discovery claim which precipitated the Klondike gold rush. (The narratives, *Discovery of Gold* told by Angela Sidney, and *My Husband's People* told by Kitty Smith, speak about their relatives, Skookum Jim, Kate Carmack and Tagish Charlie and the discovery of Klondike gold. They can be found in Julie Cruikshank's, *Life Lived like a Story.)*

Place names, a description of the environment

There are words in the languages of Yukon First Nations that describe the environment. Here are some examples:

Klondike is a variation of the Han word *Tr'ondëk.*

Goon Heeni (Tlingit), Gold Creek, is noted for its gold deposits.

T'eish Núulàa (Tagish), Charcoal (Black) Point, is a reference to coal deposits in the area.

Tsambaa'a (Tagish), "Grey Ridge" is a reference to a red ochre deposit.

Thatin Chu (Southern Tutchone), "Woman Creek." It was at this site that, unfortunately, a young girl turned into a copper pillar.

Giltana Chu (Southern Tutchone), "Flint Creek" refers to the abundance of flint found in this region.

Cha San Chuà (Southern Tutchone), "Copper Water" is presently known as McInytre Creek, a drainage of the Whitehorse Copper Belt.

Tthekal Chú (Northern Tutchone) is a creek where there is a large deposit of flat rocks used for scraping hides.

Tsé Dedatl'ise Tué (Kaska), Blue Rock Creek, refers to blue rock in the area.

Chii Deetäk (Gwichin), Rock River, known for its ochre deposit.

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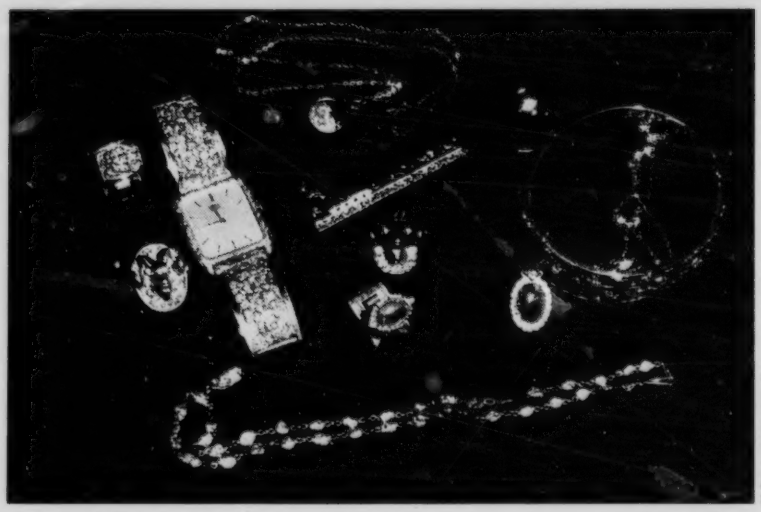
Chii Deetäk (Gwichin), Rock River, known for its ochre deposit.

IMPORTANT MINERAL RESOURCES
Present-day economies

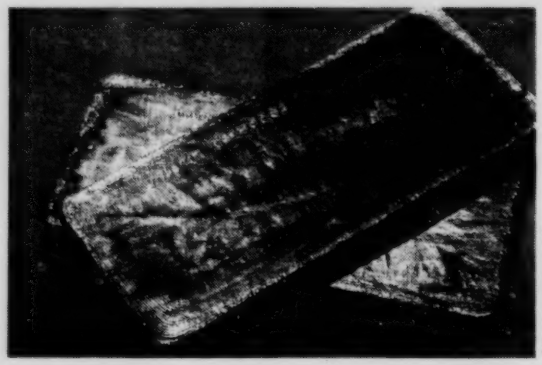
GOLD (Au)

- Gold has been highly valued for thousands of years in the western world. Approximately 3,540 tonnes are sold annually, with jewellery accounting for 80 per cent of gold's use.
- Gold is not affected by moisture or oxygen; it will not corrode or tarnish. It is a good conductor of heat and electricity. These attributes make it useful for electronics, dentistry and coins.
- Gold is a soft metal that is often alloyed to increase its strength. The purity of gold is described according to carat weight. Pure gold is 24 carat or 1000 fine.



Yukon government

Gold and silver ***Jewellery***



Yukon government

Gold ***Bars produced at Brewery Creek***

- Gold contributes to the efficiency and quality of our modern technologies. Gold is found in the following products: radar equipment, aircraft windshields, navigation circuitry, cameras, computers, camcorders, televisions, electronic circuitry, microchips, electrical contacts in airbags, and wheel contacts and connectors to prevent spinning and loss of traction in some vehicles.

SILVER (Ag)

- Globally, 14,953 tonnes of silver were produced in 1997.
- The light sensitivity of silver salts makes silver an integral part of the photographic process. It is used in the manufacture of film, photographic paper, x-ray film, photo-offset plates and other light sensitive products.
- Silver has the best thermal and electrical conductivity of all known metals.
- Silver is also used in the following products: contact and conductor products for the electrical and electronic industry, mirrors, dental amalgams, bearings, jewellery and silverware.

Yukon government

Gold and silver ***Computers at Hidden Valley School***

LEAD (Pb)

- Lead is the world's fifth most used and most-recycled metal. Nearly 80 percent of the lead in the western world is recovered. Most recycled lead comes from batteries.
- Over five million tonnes of lead are produced annually in the western world. Consumption has increased by two per cent per annum.
- Batteries account for over two-thirds of all lead consumption, with the predominant use being in car batteries. The average car battery contains 10 kg of lead. It can also be found in battery powered vehicles such as wheel chairs, golf carts and electric cars. The batteries that drive these vehicles are emission free and, using recycled lead, can easily be manufactured in high volumes for a low cost.
- Other uses of lead include: alloys, pigments, chemicals, fine crystal and stained glass windows. Products with lead also provide protective barriers from noise and air pollution, and radiation.
- Despite its many uses, lead is toxic. If ingested and absorbed into the blood stream, it can cause adverse health effects in animals and humans.

ZINC (Zn)

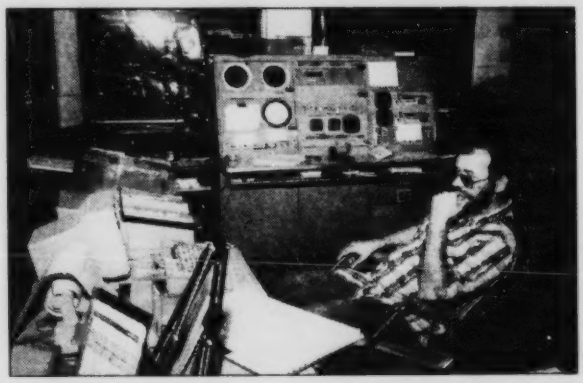
- Zinc is the world's fourth most used metal, after steel, aluminum and copper.
- Approximately 6.5 million tonnes of zinc are consumed annually in the western world. Consumption has increased by two per cent per annum since 1980.
- Products of zinc include: automobiles, roofing materials, coins, faucets, multi-vitamins, galvanizing agents, anti-corrosive plating, skin cream, die casting, pharmaceuticals, cosmetics and the kitchen sink.
- Zinc is completely recyclable without any loss to its physical and chemical properties.
- Zinc is essential to human health. Adults require a daily intake of 15 mg of zinc.
- Zinc has healing properties that are useful in throat lozenges, sunscreens, first aid ointments, baby lotions and dandruff shampoo.

Yukon government

Zinc, lead and copper ***Mic Mac Motors, Whitehorse***

COPPER (Cu)

- Approximately 11 million tonnes of copper are consumed annually in the western world. Consumption has increased by three per cent per annum since 1980.
- Copper has superior electrical and thermal conductivity. Seventy per cent of all copper mined is used in wiring and cable. Copper can also be found in plumbing, appliances and hardware.
- For centuries, copper has been used worldwide as a roofing metal on buildings and churches, and for sculpting.
- Copper is combined (alloyed) with zinc to make brass. Brass is combined (alloyed) with tin to make bronze. These decorative alloys are found in sculptures, jewellery and furniture.
- Copper is essential to human health. Adults require a daily intake of 2 mg of copper.



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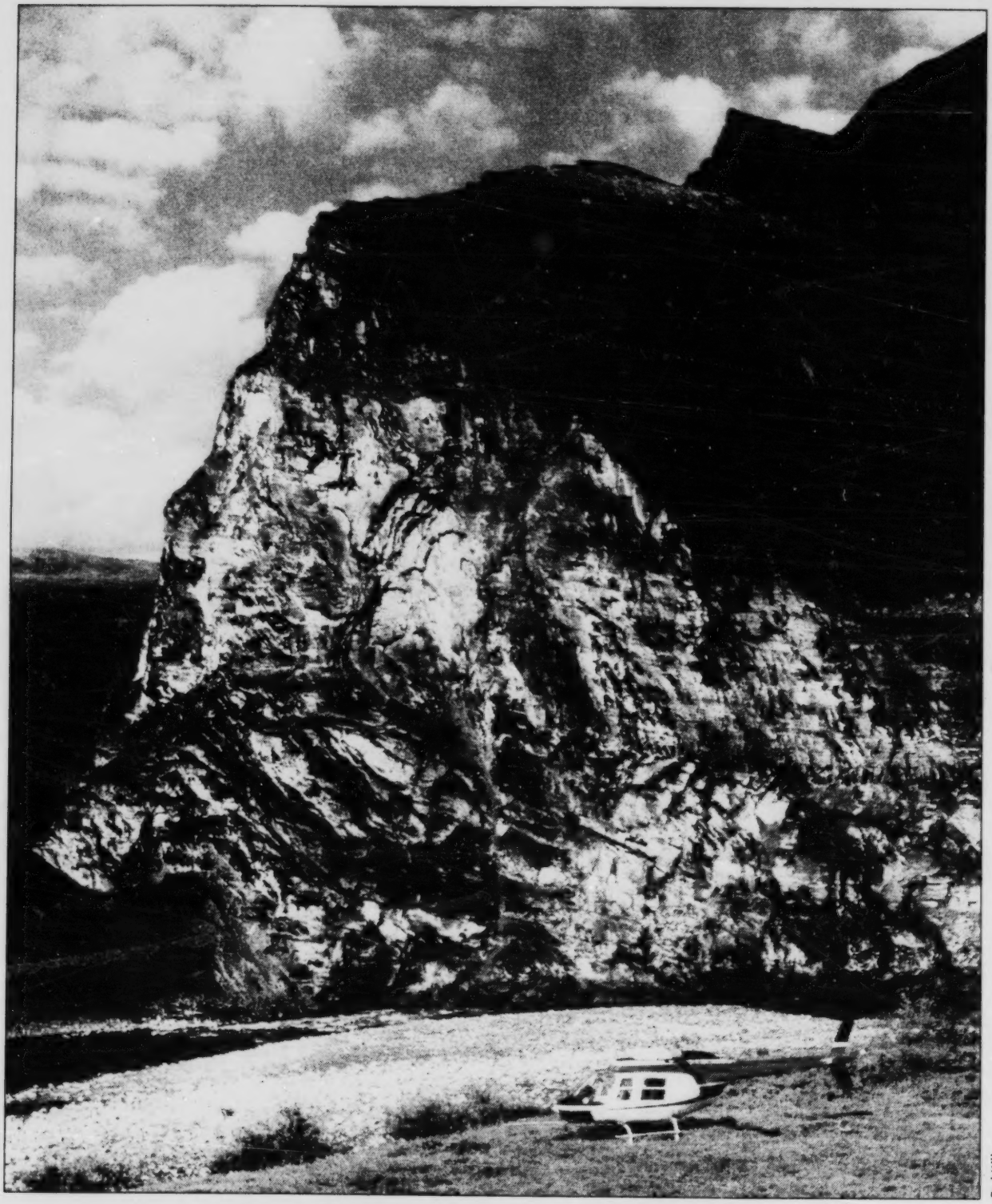
Gold and silver ***Mayo weather station***



Rod Hill

The National Museum of Nature sent a crew to look for unique lazulite in phosphate-rich ironstone in the Rapid Creek area in northern Yukon.

GEOLOGY: SOLVING THE PUZZLE

The Yukon's geology is complex and full of surprises. Over the years, areas previously explored for minerals have been revisited with innovative technology and geological modelling, resulting in the discovery of new deposits. The complex geological history of the Yukon's rocks, combined with the fact that our territory has not yet been fully explored, creates the potential for large discoveries.

THE YUKON'S GEOLOGY

The Yukon's geology can be roughly split into two rock groups: those north of the Tintina Fault and those south of it. This dividing line cuts northwest to southeast across the territory from Alaska to northern British Columbia.

Each side of this boundary is characterized by different types of rocks containing different types of mineral deposits, some being mined or explored, and many yet to be discovered.

The Tintina Fault

This extensive feature, although inactive today, is a zone where fragments of the earth's crust slid sideways. Most geological evidence suggests that the rocks southwest of the fault moved northwest by at least 450 kilometres, and perhaps as much as 1,200 kilometres.

The Tintina Trench is the sizeable valley formed by the erosion of the Tintina Fault zone. It is one of the most distinctive and significant physical features of the territory. The communities of Ross River, Stewart Crossing, Faro and Watson Lake are located in the trench. (See map, page 17.)

Don Murphy

Looking across the Ings River, near the Campbell River, Pelly Mountains, east of the Tintina Trench.

"Good Old" North America

Northeast of the Tintina Fault are the components of the ancient North American continent which is underlain by a very old stable part of the Canadian Shield.

Exploration has led to the discovery of copper-lead-zinc deposits. Gold, copper and uranium have been found in breccia. Breccia refers to rocks which have been shattered by very hot gases and fluids heated by deep molten rock, or broken by fault movement. In the process of this rock splitting, minerals are precipitated and cement the rock fragments together.

Important lead-zinc deposits are found in a large area of sedimentary rocks called the Selwyn Basin. Most of the Yukon's base metal production comes from these rocks,

THE TINTINA GOLD BELT: The hardrock mining gold rush of the new millennium?

The Tintina Gold Belt contains mineral deposits rich in gold, silver, tin, copper and tungsten. This belt has produced over 30 million ounces of gold and contains an additional 40 million ounces of gold reserves. Several large deposits in Alaska have been found within this geological zone, including the high-tonnage, low-grade, Fort Knox gold deposit.

In geological terms, the Tintina Gold Belt includes an array of 92-million-year-old granitic rocks belonging to the Tombstone Plutonic Suite. This suite, or family of rocks, consists of plutons spread across a 550-kilometre zone situated between Dawson City and the MacMillan Pass. Mineralization is concentrated in the plutons but exploration has revealed that deposits may be present even in the surrounding rocks. The Brewery Creek mine, the Yukon's first heap leach gold mine, is related to rocks belonging to the Tombstone Plutonic Suite.

The Tintina Gold Belt also hosts world class tungsten deposits (CanTung mine and the MacTung deposit) and various tin and copper occurrences. Mines within the Tintina Gold Belt have produced 190 million ounces of silver and more than 500,000 ounces of placer gold.

Major gold deposits in the Tintina Gold Belt

most notably the large deposits near Faro. Near Elsa, silver-zinc-lead veins occur along a 30-kilometre belt and have produced more than 6.4 billion grams (186 million ounces) of silver.

The accreted terranes

...*new kids on the block*

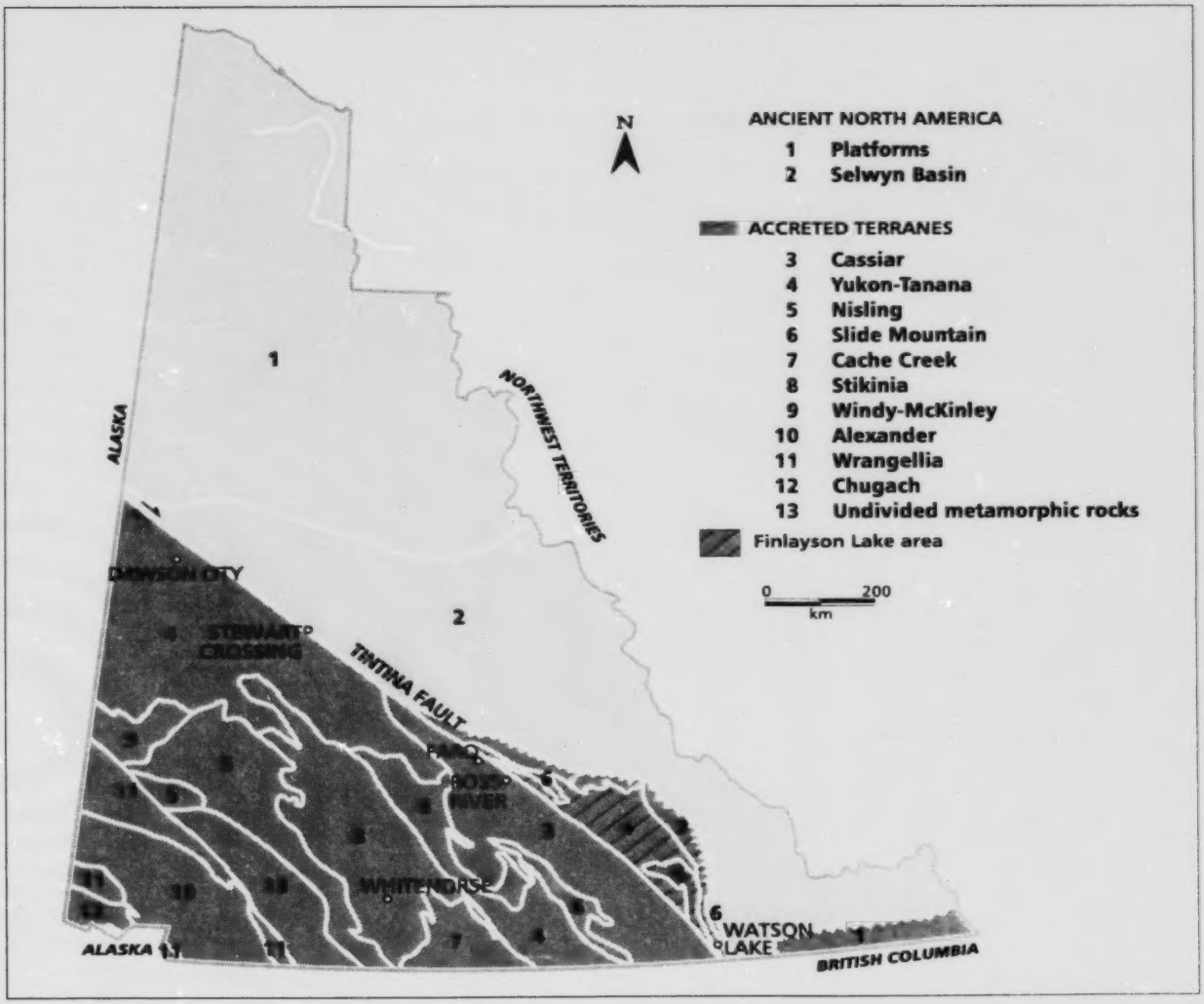
Southwest of the Tintina Fault, the accreted terranes, or smaller fragments of the earth's crust, were carried around on oceanic plates until they collided with the margins of ancient North America between 160 million years and 120 million years ago. It created a jumbled mix of different geological formations.

Several copper-gold-molybdenum and copper-gold deposits, including the Carmacks Copper, Casino, and Minto projects, are found within a 100-kilometre belt in terranes located in central Yukon.

...*Finlayson Lake area*

South of Ross River, massive sulphide discoveries have attracted national interest, spurring exploration booms in 1995 and 1996. These deposits contain large concentrations of copper, zinc, lead, gold, silver and cobalt. There has been extensive exploration in the Finlayson Lake area. Feasibility work is on-going at the Kudz Ze Kayah and Wolverine deposits. (See map, page 21.)

THE ACCRETED TERRANES IN SOUTHWEST YUKON



RARE EARTH ELEMENTS

The Rare Earth Elements (REE) are found in two horizontal rows at the bottom part of a periodic table of the elements. Elements like lanthanum, cerium and neodymium are less well known than elements like gold, zinc and copper. Many of the rare earth elements are actually quite common. However, it is unusual to find them in large concentrations.

Traditionally, rare earth elements were used in the oil refining industry. In recent years, however, new applications for REE have been found in high technology products and research. At the research level, REE are associated with super-conductors, new battery compounds, low-cost automobile catalytic converters, high quality optics and lasers, and magnets found in most new electric motors. Although there are REE mines in California and Brazil, China controls over 70 per cent of world supplies.

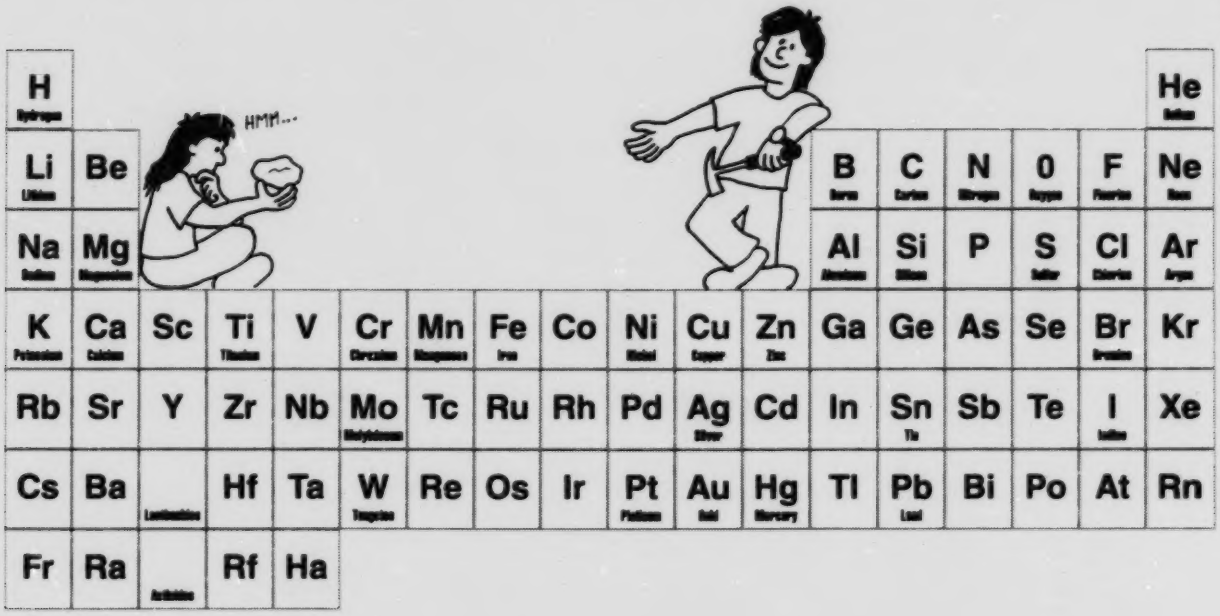
Geologist James Dodge holds a rare earth claim, called the Lancer (from Lanthanum and Cerium) deposit, in the headwater country of the Ketza River, south of Ross River. Dodge, who is 80 years old and still spends 60 to 70 days a year in the field, generally solo, holds several degrees in geology. He first worked in the Yukon in 1960 and has returned here frequently over the years.

With the assistance of the Yukon Mining Incentives program, Dodge was able to survey the area. He found it contained a larger and richer vein than previously thought. Assay work, supported by the Canada/Yukon Mineral Development agreement, showed commercially viable concentrations of REE.

In addition to the 15 rare earth elements, the assay report also identified concentrations of niobium and yttrium. Niobium is used in the extremely strong steel alloys that find their way into rocket chassis and jet engines, among other applications. Dodge estimates the claim contains one to two per cent of known world reserves, which he tentatively values in situ at US$300 million.

So why isn't there a mine on the Lancer property right now? REE deposits are expensive to process. They are generally only found in extremely small particles. This means that the ore-bearing rock must be ground very finely, or as Dodge puts it, "finer than table salt but coarser than flour." This is both expensive and time consuming. Although the individual metals are often highly sought after by industrial users, the concentrate itself would have to be sold to a very limited number of specialized refineries in the world. These complications make it difficult to find venture partners.

If, however, rare earth applications continue to be found in the fast moving world of high technology research, then REE could quickly become a very valuable commodity indeed.



Rock-on Yukon grade 5 curriculum, Yukon Chamber of Mines

YUKON GEM RUSH?

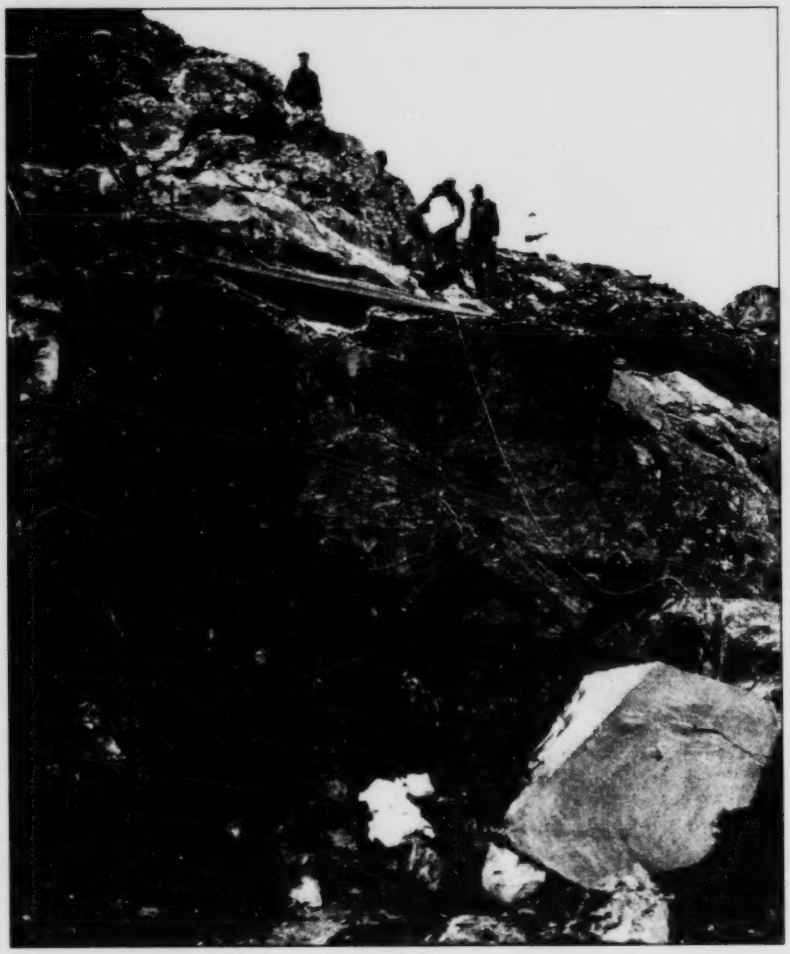
Canadian gemologist Brad Wilson is convinced the geological conditions in the Yukon offer good potential for finding some of the rarest gemstones in the world. Over the past 20 years, he's been coming to the Yukon regularly from his home in Kingston, Ontario.

"I'm looking for gemstones like rubies, sapphires, aquamarine, garnets, topaz and tourmaline," Wilson said. "There are several geological environments in which sapphires occur and one of those environments is in the Yukon. I've found opaque sapphire." These gems form deep in the earth and are tossed out by volcanoes. The magma, which encases the gems, gradually weathers away over millions of years. Any hard crystals, showing a six-sided shape or spindle shape, should be examined.

According to L. Walton, in *Exploration Criteria for Gemstone Deposits and Their Application to Yukon Geology,* many deposits were found by accident. The author suggests that the easiest way to find Yukon rubies and sapphires is to look in streams that lie in areas where volcanic activity occurred and which escaped glaciation. Gemstones can also be found in placer concentrate.

The discovery of diamond-bearing kimberlite in the Northwest Territories has generated a lot of interest in the potential discoveries of gems. In the Yukon, the potential for other gemstones exists and it is quite possible that areas previously prospected, as well as new areas, may show some promise as gem targets.

"I've found some very interesting light green and brownish garnets," Wilson said. "Very few mines in the world are actively producing green garnet. For many years, green garnets were exceedingly rare, and the prices were very high. If I could find a green garnet locality here, that would be great."



Dennis Ouellette

Largest Nephrite jade discovery in the world, King Arctic Mine, north of Watson Lake.

Placing a value on gemstones is very difficult since there is no standard grading system for coloured gemstones as there is for diamonds. Instead, value is based on beauty, rarity, durability, the stone's history and the deposit from which it was mined. Many gems have industrial uses even if they are not "gem quality." For example, corundum, a relative of rubies and sapphires, is mined for its use as an abrasive, polishing or grinding agent.

Favourable geology also exists for tourmaline, aquamarine, topaz and gem garnet.

In 1998, Vancouver-based Expatriate Resources discovered emeralds on one of its exploration properties near Finlayson Lake. The company commissioned a team of gem experts to evaluate the find. Gem-quality emeralds are extremely rare and much work is needed to recover and appraise the rough gems.

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YUKON TOP MINING PROJECTS, 2001

PROPERTY	RESERVES	STATUS
OPERATING MINES		
Brewery Creek Viceroy Resource Corporation	**Mineable reserve:** 3,100,000 tonnes 1.59 grams/tonne gold (as of December 31, 1999)	Total production for 2000 estimated at 45,000 to 50,000 ounces.
UNDER CONSTRUCTION		
Minto Grupo Mexico S.A. de C.V./Minto Explorations Ltd.	**Mineable reserve:** 6,510,000 tonnes 2.13% copper, 9.3 grams/tonne silver 0.62 grams/tonne gold	Water licence is signed. Production decision depends on metal prices.
DEVELOPMENT PROJECTS		
Keno Hill United Keno Hill Mines Ltd.	**Mineable reserve:** 520,000 tonnes 6.64% lead, 4.95% zinc 1,049 grams/tonne silver	On hold.
Dublin Gulch New Millenium Mining Ltd.	**Mineable reserve:** 50,400,000 tonnes 0.93 grams/tonne gold	Undergoing final stages of environmental assessment.
Kudz Ze Kayah/ Wolverine (Finlayson Project) Expatriate Resources Ltd. (Atna Resources owns 40% of Wolverine)	**Total probable reserves:** 14.57 million tonnes 0.97% copper, 1.53% lead, 7.23% zinc 184.5 grams/tonne silver 1.39 grams/tonne gold	Joint development planned. Pre-feasibility complete. Amendments to permits underway.
Carmacks Copper Western Copper Holdings Ltd.	**Mineable reserve:** 14,109,800 tonnes 1.01% copper, 0.51 grams/tonne gold	Undergoing final stages of environmental assessment.
EXPLORATION PROJECTS		
Wolf Atna Resources/ YGC Resources	Zn-Pb-Ag volcanogenic massive sulphide target Inferred resource of 4.1 million tonnes grading 6.2% zinc, 1.8% lead and 84 grams/tonne silver	Delineation drill program complete (6,625 m, 30 holes). Deposit strike length 600 m, down-dip length 450 m, good continuity of sulphide mineralization, deposit is open.
Mt. Skukum/Skukum Creek Goddell Tagish Lake Gold Corp.	**Mineable reserve:** *Rainbow Zone:* 956,949 tonnes @ 6.3 grams/tonne gold, 193.5 grams/tonne silver *Kuhn Zone:* 148,781 tonnes @ 8.78 grams/tonne gold, 167.70 grams/tonne silver *Goddell Zone:* 900,000 tonnes @ 7.0 grams/tonne gold	Resource/reserve definition planned.
Fyre Lake Pacific Ridge Exploration	**Preliminary resource:** 15.4 million tonnes within which 8.2 million tonnes grade 2.1% copper, 0.11% cobalt, 0.73 grams/tonne gold	Preliminary reserve estimate based on wide-spaced drill holes.
Clear Creek Redstar Resource Corporation	Gold-bismuth and gold-arsenic intrusive-related targets.	2000 drill program complete.
Fire/Ice Eagle Plains Resources	Volcanic massive sulphide properties	2000 drill program complete.
McQuesten NovaGold/Eagle Plains Resources/Newmont Exploration	Multiple styles of mineralization-gold targets.	2000 drill program complete.
Canadian Creek Alexis Resources Ltd.	Prophyry copper-gold and intrusive related gold targets.	2000 drill program complete.

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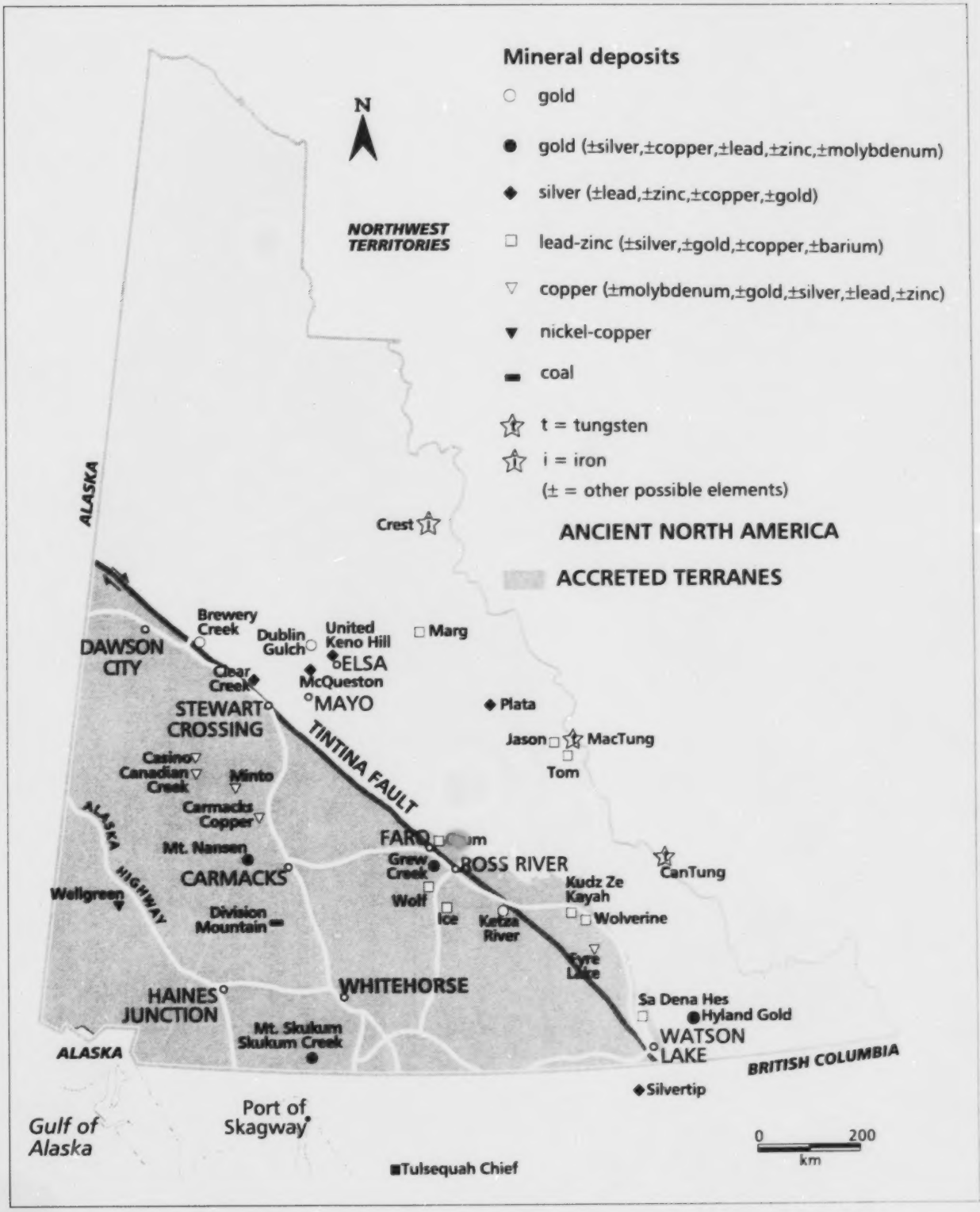
Dublin Gulch New Millenium Mining Ltd.	**Mineable reserve:** 50,400,000 tonnes 0.93 grams/tonne gold	Undergoing final stages of environmental assessment.
Kudz Ze Kayah/ Wolverine (Finlayson Project) Expatriate Resources Ltd. (Atna Resources owns 40% of Wolverine)	**Total probable reserves:** 14.57 million tonnes 0.97% copper, 1.53% lead, 7.23% zinc 184.5 grams/tonne silver 1.39 grams/tonne gold	Joint development planned. Pre-feasibility complete. Amendments to permits underway.
Carmacks Copper Western Copper Holdings Ltd.	**Mineable reserve:** 14,109,800 tonnes 1.01% copper, 0.51 grams/tonne gold	Undergoing final stages of environmental assessment.
EXPLORATION PROJECTS		
Wolf Atna Resources/ YGC Resources	Zn-Pb-Ag volcanogenic massive sulphide target Inferred resource of 4.1 million tonnes grading 6.2% zinc, 1.8% lead and 84 grams/tonne silver	Delineation drill program complete (6,625 m, 30 holes). Deposit strike length 600 m, down-dip length 450 m, good continuity of sulphide mineralization, deposit is open.
Mt. Skukum/Skukum Creek Goddell Tagish Lake Gold Corp.	**Mineable reserve:** *Rainbow Zone:* 956,949 tonnes @ 6.3 grams/tonne gold, 193.5 grams/tonne silver *Kuhn Zone:* 148,781 tonnes @ 8.78 grams/tonne gold, 167.70 grams/tonne silver *Goddell Zone:* 900,000 tonnes @ 7.0 grams/tonne gold	Resource/reserve definition planned.
Fyre Lake Pacific Ridge Exploration	**Preliminary resource:** 15.4 million tonnes within which 8.2 million tonnes grade 2.1% copper, 0.11% cobalt, 0.73 grams/tonne gold	Preliminary reserve estimate based on wide-spaced drill holes.
Clear Creek Redstar Resource Corporation	Gold-bismuth and gold-arsenic intrusive-related targets.	2000 drill program complete.
Fire/Ice Eagle Plains Resources	Volcanic massive sulphide properties	2000 drill program complete.
McQuesten NovaGold/Eagle Plains Resources/Newmont Exploration	Multiple styles of mineralization-gold targets.	2000 drill program complete.
Canadian Creek Alexis Resources Ltd.	Prophyry copper-gold and intrusive related gold targets.	2000 drill program complete.

IMPORTANT HARDROCK MINING PROJECTS AND MINERAL DEPOSITS



MY DAD'S A GEOLOGIST AND...

Interview with Melissa Mann, 10 years old

...he's out of town a lot, sometimes for weeks, sometimes for months...then he'll be home for a while... usually he's home more than he's gone...

This is usually one of the first things we learn about geologists, the amount of time spent away from family and friends, working in the field. But it sounds like an interesting life.

...sometimes he gets new rocks and has to look at them...he usually tells me what kind it is, 'cause he knows most of the kinds and sometimes he'll show me where he got them...on a map. He's got lots of rocks at our house. Outside. Inside. In his office... I know some kinds, just a few though, like the kinds in the yard.

Geologists study how the surface of the earth has formed over great time periods. It is like a jigsaw puzzle where important pieces of the story are discovered each field season. These discoveries enrich our lives by giving us knowledge about our planet. This is very important as it gives exploration geologists clues to where there might be important mineral deposits.

Bill Mann

Melissa Mann preparing drill core.

There are other interesting experiences and knowledge of nature that can be brought home and shared after working in the field.

...once he was hiking in the mountains and he found a mountain goat horn or something...it was really old and fragile...we have a moose antler in the backyard too...

MINING: A WALK THROUGH THE STAGES

The complex process of finding ore bodies that can be mined at a profit is a difficult task which is often poorly understood. Establishing a producing mine is the result of a long process.

EXPLORATION

Over the last ten years, an average of $23.3 million was spent annually on exploration in the Yukon.

Exploration is distinct from mining. The detective work of exploration involves as much intuition as science. The process of discovering and evaluating mineral deposits requires constant decision making involving many intangibles.

Prospecting

Exploration starts with prospectors looking for rock with unusual amounts of metal-bearing minerals.

Successful prospecting involves much more than identifying minerals in the field. Good prospectors do their homework well before the season when they go out into the field. They study maps showing information about the glacial history, geology, geochemistry and geophysics of the areas in which they are planning to work. They visit a mining recorders' office to determine if the area is within First Nation land claims, or if it is already staked. Information from previously evaluated mineral claims helps prospectors choose where and how to work. Typically, ore bodies are found after claims have been worked several times by different owners.

The environmental impact due to prospecting is usually low to non-existent as crews and camps are small (one to five people) and travel is by foot, boat and occasionally helicopter or floatplane. These are low-budget and low-impact activities.

Yukon government

A geologist examines core samples, a critical step in exploration.

M121

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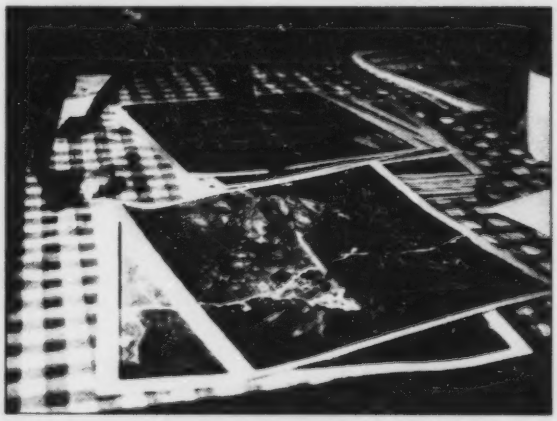

Jeff Bond

Getting ready for the field: air photographs are one source of information.

Jeff Bond

Field office at a small exploration camp.

Staking

If prospectors or mining companies discover signs of mineral wealth, they may then choose to stake a mineral claim over their find. Staking a claim can be time-consuming and hard work and is only necessary if they think they have a significant find, or they are worried about someone else staking it. Mineral claims are staked according to procedures defined in the federal *Yukon Quartz Mining Act*. After a claim is staked, the prospector or company records the claim at the mining recorders' office. Prospectors may spend a minimum of $100 per year in research, analysis, or field work to maintain each claim or, annually, they may pay a flat renewal fee of $100 per claim. They may also file annual assessment reports to government agencies on the work that they have done. If these conditions are not met, the claims lapse and the assessment reports become public information.

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Extensive exploration is usually necessary to evaluate a promising mineral occurrence. Hand or machinery trenching down to bedrock and drilling are required to reveal more information about the type, size and grade of the deposit. Airborne geophysical surveys are sometimes useful to find or outline mineral deposits without anyone setting foot on the ground.

How do prospectors make money?

Prospectors focus on "grassroots" exploration. They cover large areas and find promising indicators. Generally, they have limited funding and cannot completely assess a mineral property.

In most cases, prospectors need to raise money to look for mineral deposits. Often, prospectors will turn to a junior or senior mining company and "option" a promising mineral property to the company. The option agreement allows the company to earn an interest in the project by doing work on the property and making option payments to the original claim holder, the prospector. The prospector may also earn revenue by selling the rights to further explore an interesting property, or to mine a deposit.

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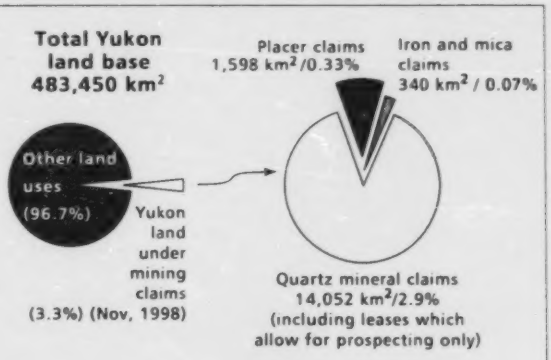
Most claims change hands many times before a mine is established. It can take at least three companies and many years of exploration to discover and develop a mine in the Yukon. Fifty million dollars may have been spent by this time. Despite the large amount of money spent on exploration, the chances of finding a mineable deposit are low.

YUKON LAND UNDER MINING CLAIMS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Yukon Bureau of Statistics

Exploration is carried out by individual prospectors and mining companies. Senior or large mining companies with income from producing mines may fund exploration. In-house junior or smaller mining companies are in the business of exploration only. Junior companies finance their year-to-year operations by selling shares on stock exchanges, such as the Canadian Ventures Exchange. This kind of stock exchange recognizes both the high risk of exploration and the high reward if a mine is found.

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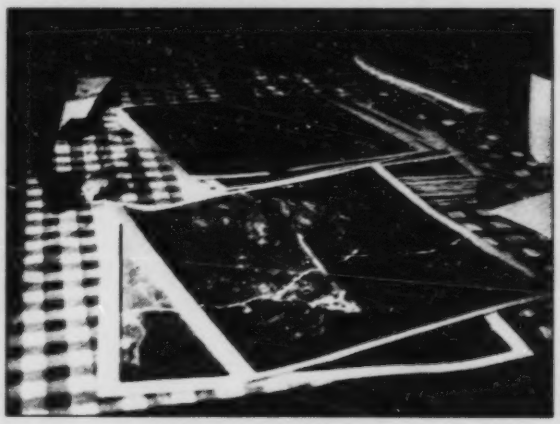

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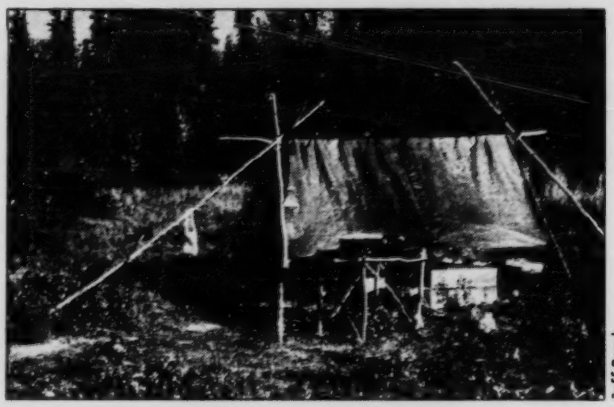

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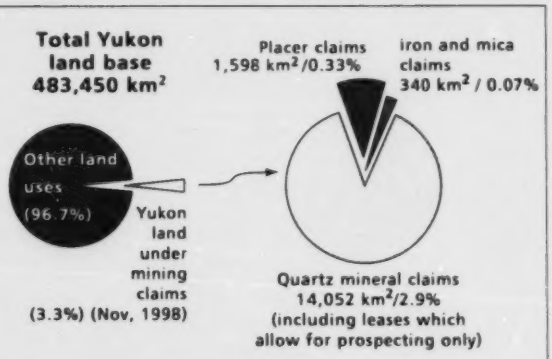
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Working on a diamond drill.

CONSTRUCTION AND PRODUCTION

Upon receiving a water licence, the construction of the mine infrastructure will begin. A final production decision will be made during the construction phase.

RECLAMATION AND CLOSURE

When the ore body is exhausted, the buildings and equipment are removed. Reclamation is completed to encourage the area to return to a natural state.

There have been many changes in the regulations dealing with the environmental impact of mining in the Yukon. Companies must now provide plans and insurance that ensure reclamation work and mine closure will take place in a satisfactory manner.

In the Yukon, as in the rest of Canada, mines that have gone into production during the last five to ten years have undertaken extensive research into reclamation and incorporated their reclamation objectives into their daily operations. With an abandonment plan in mind from the start, tailings, overburden and structures are dealt with in such a way that their final disposition is feasible and affordable. It makes sense for the environment, and it makes a lot of sense financially.

The reclamation of mines that opened before current regulations were established is a difficult and expensive process, as is the case with many other past land uses. New regulations, and an overall expectation from the Canadian public, stress the importance of sound environmental management in the resource-based industries.

The industry is responding and changing. Canada is becoming a leader in reclamation technology and methods, bioremediation and environmental research.

STAGES OF MINING

PERMITTING PROCESS STAGES		YUKON PROJECTS
	REGIONAL EXPLORATION • Prospecting • Regional surveys	Finlayson Lake area McQuesten Intrusive Belt (Mayo to Dawson City area) Dawson Range Cu/Au Belt
	PRELIMINARY EXPLORATION • Discovery of mineralization • Delineation of mineral zone • Magnitude of deposit	Wolf Division Mountain Clear Lake Grew Creek
Environmental baseline studies	**ADVANCED EXPLORATION** • Diamond drilling • Trenching	Hyland Gold Marg Ice
Permitting process begins Company submits project overview Company submits Initial Environmental Evaluation (IEE)	**PRELIMINARY FEASIBILITY STUDY** • Ore reserves • Scale of operation • Development plan • Capital costs • Operating costs • Cash flow • Net present value	Ketza River Mount Skukum/Skukum Creek Wellgreen Crest Fyre Lake MacMillan Pass – Tom, Jason Casino Kudz Ze Kayah/Wolverine
	TEST MINING PROGRAM • Obtain bulk sample • Test ore continuity • Identify mining problems	Silvertip, B.C. Dublin Gulch Carmacks Copper Sa Dena Hes
Water licence application	**FINAL FEASIBILITY STUDY** • Similar to preliminary but more detailed • Budget for operating and capital costs • Cash flow projection	Tulsequah Chief CanTung
Water licence received	**CONSTRUCT MINE, MILL AND PLANT**	United Keno Hill Minto
	PRODUCTION	Cassiar, B.C.
	RECLAMATION	Brewery Creek

Yukon government

Tailings from an operation near Dawson City.

Ken Galambos

Prospector with rock sample.

PLACER MINING: GOLD IN THE WASH

The term "placer" is a Spanish word, meaning "a place where gold can be recovered from gravel." As this suggests, placer mining is the technique of recovering gold from gravel. Throughout history, it has been practised around the world. The story of Homer and the Golden Fleece refers to the sheepskins used in Asia to collect gold; a method of placer mining. The heavier gold was caught in the fleece.

Placer deposits occur in several areas in the Yukon, though historically, most of the mining has taken place near Dawson City. This area is particularly favourable for placer deposits because it is in the unglaciated part of the Yukon.

Most of the southern Yukon and large parts of the rest of North America were once covered by glaciers. Glaciers tend to rework and dilute placer gold deposits by mixing gold-bearing gravel with large amounts of other sediments. However, during the last ice-age, the Dawson City area was not covered by glaciers. This left rich gold deposits along Bonanza and Eldorado creeks. This area was later known as the Klondike goldfield. Approximately 80 per cent of the Yukon's placer gold is currently mined from the Klondike and other unglaciated parts of the territory.

THE HEART OF DAWSON CITY'S ECONOMY

Placer mining is particularly important to the economy of Dawson City. According to a 1994 Yukon government study, mining contributed 5,226 person-months of employment per year, more than any other Dawson City industry at that time. The total income earned by placer mining was just under $22 million. The 1994 study also concluded that placer mining provided the greatest economic spin-offs to service businesses in the Dawson City area. This was attributed to the following factors: higher incomes, longer working hours, the influx of non-resident miners and their families, and the capital-intensive nature of mining and

William LeBarge

Placer operation in the Klondike area. Settling ponds are visible in the foreground. Dark grassy areas were worked the previous year and are quickly revegetating.

local purchases. Placer mining requires large amounts of fuel as well as parts for equipment maintenance. These purchases made up 75 per cent of the total operational spending by placer mining.

In 2000, the number of placer mines and the value of gold production decreased significantly from 1999. A total of 450 people were employed at 140 placer mines. Gold production was 76,507 crude ounces compared with 87,680 crude ounces for 1999 and the gold production dollar value was C$25.4 million compared with C$29.7 million in 1999.

Placer gold is getting more difficult to find as reserves in traditional placer mining areas decline. By expanding knowledge of placer gold deposits and applying it to other areas, new sources of placer gold may be discovered in different geological settings.

FORMATION OF PLACER DEPOSITS

Placer deposits consist of loose material (gravel, sand and clay) formed by the weathering of mineralized bedrock. As the bedrock breaks down, heavy minerals like gold, silver, platinum, tin, copper, tungsten and some gemstones are released. These minerals become concentrated on the bottom of creeks and form a pay streak.

C. Mougeot

Permafrost is a special consideration for mining projects. Pictured here is a placer cut near Dawson City.

• F U N • G O L D • F A C T S •

"Au" - the chemical symbol for gold, from the Latin "aurum" meaning "shining dawn." Aurora was the roman goddess of dawn.

The total amount of gold mined in the world since 3900 BC would fit into an 18 x 18 x 18 metre cube.

Chryso is the Greek word for gold.

In English, a "crysophile" is a lover of gold.

An ounce (31.1 g) of gold can be stretched into a wire 100 km long.

Gold can be hammered so thin that a cup of it could be flattened over an entire football field.

1,000 sheets of gold leaf equal the thickness of a human hair.

The rarest form of gold is a nugget. The largest known nugget, the Welcome Stranger, weighing about 70.8 kg was turned up accidentally, just below the surface of the ground, by a wagon wheel in Victoria, Australia, in 1869.

South Africa is the world's leading supplier of gold.

Gold reached an all-time high price of US$800 per ounce in 1980.

An authentic gold nugget is considered a gemstone because of its rarity and beauty.

Even though gold is rare, it is far easier to find than to win a major lottery.

There are about 10 billion tons of gold in the world's oceans, however, there is yet no known way to economically recover it.

from: www.goldfever.org/GoldFever-Fun-facts.htm

FARMING THE GOLDFIELDS

"The placer mine is the family farm of the north," says miner Mike McDougall. Many of the farm folk from the Canadian prairies find their way to the goldfields of the far northwest. He lists a number of parallels between growing grain under the expansive skies of the prairies and sluicing for gold in the forested valleys of the Yukon.

The working environments and lifestyles are similar. In both cases, people work in isolated settings with their nearest neighbours several kilometres away. The "growing season" is short. Placer miners usually sluice from June to mid-September when the water and ground are not frozen.

Like farmers, placer miners need to work long, hard days, taking few holidays, to make their money within this narrow window of time. In some years, the crop is better than others. Like agriculture, the "crop" is an internationally traded commodity and the "grower" has no control over the price.

Skills and a working style learned on the family farm are essential in the placer mining business. Self-reliance is key. The successful operator must not only be able to run heavy equipment but to fix it as well.

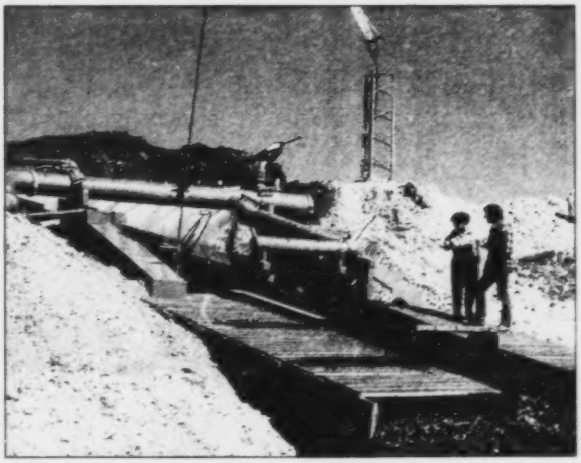
William LeBarge

Families and students are often part of the placer operation.

Veteran placer miner Norm Ross confirms that a lot of farm kids from Saskatchewan and Alberta gravitate to the goldfields of the Yukon, largely through word of mouth.

Jeff Bond

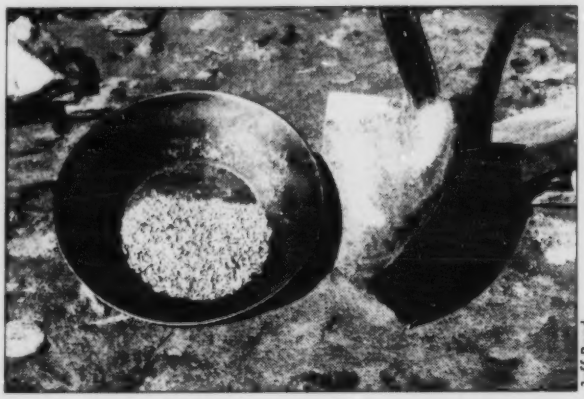
Small crews make the best of the long days to fit in all the work before fall.



Yukon government

A sluice at Norm Ross' placer site.

TOOLS OF THE PLACER MINER: Gold pan and water



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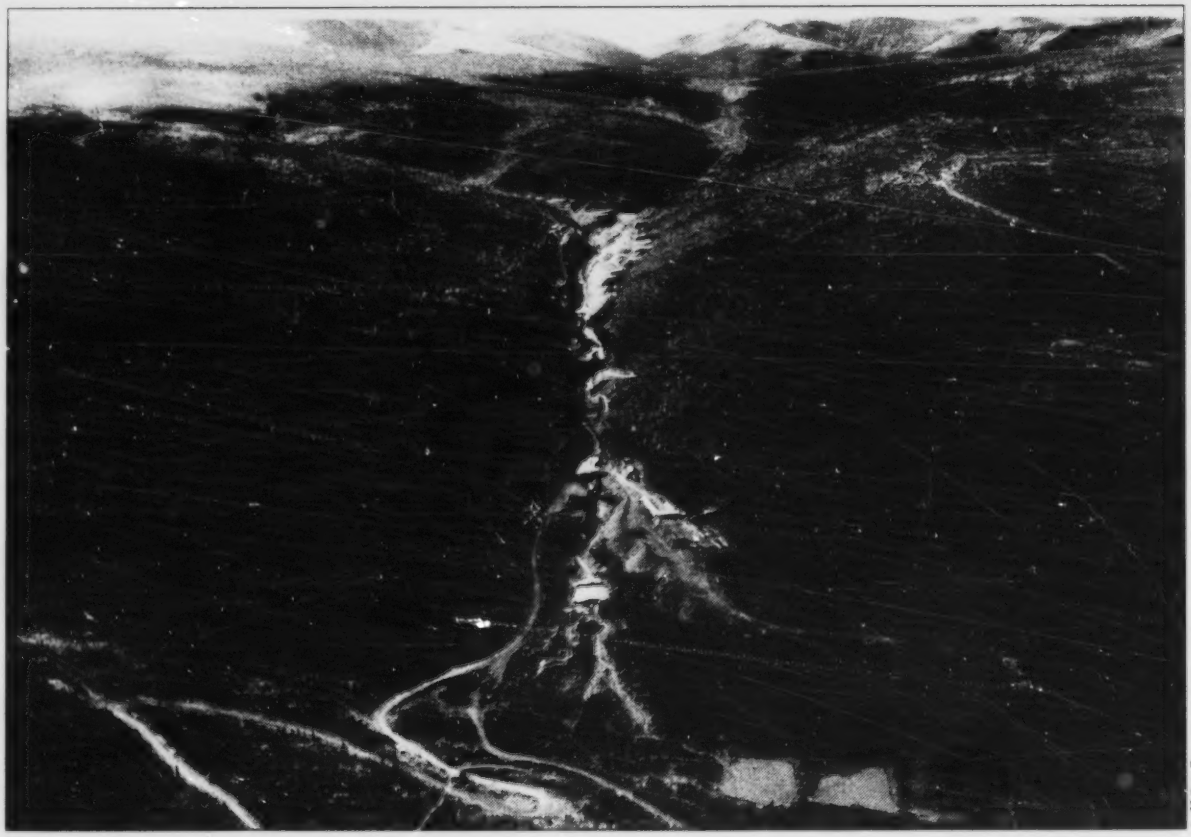
The GOLD PAN is used to test prospective gravels for gold.



Jeff Bond

WATER is usually used as the transporting or washing agent to remove the gold from the sand and gravel. The water is often pumped from a stream into an elaborate system of pumps and settling ponds. Later it is returned to the stream once the fine sediments have settled.

TOOLS OF THE PLACER MINER: Sluicebox

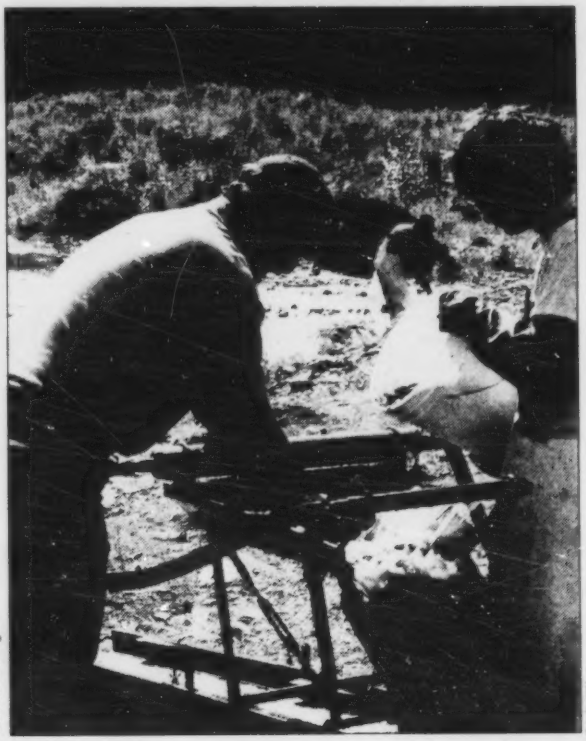
After stripping the vegetation, topsoil and overburden, gold-bearing gravel is excavated, screened and washed through a SLUICEBOX. Lighter minerals such as silt and clay flow through while gold and other heavy minerals settle in the sluicebox. Some of these other minerals are magnetic and can be separated from the gold by a magnet. The end products are gold concentrate and tailings.

A sluicebox can vary substantially in size and design.

Yukon Contaminants Curriculum, Northern Contaminants Program

William leBarge

Gold-rich gravel is dumped into a sorting box. Larger rocks come out in a pile and the finer particles run through a sluicebox.



Rod Hill

Working the sluicebox, an essential part of the processing of placer gravel.

PORTRAIT OF AN ENGINEER...RANDY CLARKSON

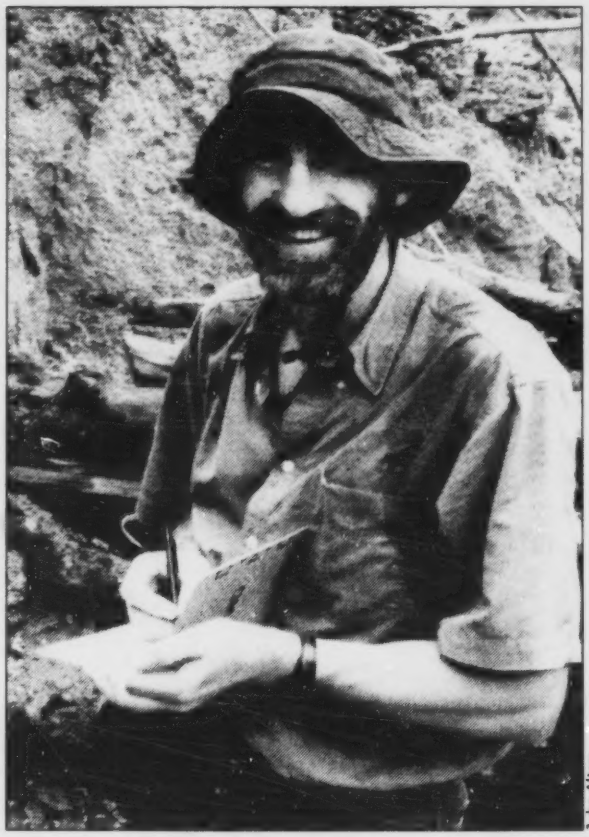
Whitehorse mining engineer Randy Clarkson spends a lot of time on airplanes. He takes with him a small lead-lined box, containing tiny flakes of gold that have been mildly irradiated at the Slowpoke Research Reactor at the University of Alberta, in Edmonton. Randy has taken this gold to placer mines in Dawson City in the Yukon, to Guyana, and to a hardrock mill in northern Ontario to evaluate the efficiency of gold recovery in sluiceboxes.

Randy feeds a tiny sample of irradiated gold into the head of a sluicebox. Using a scintillometer, he can accurately measure how much gold is recovered at the end of the sluicing process. If all the gold is not recovered, an estimate of the recovery is provided. The sluicebox can be improved and tested again.

Irradiate is a word that often triggers alarm. The gold Randy uses is mildly radioactive. It has a half life of 2.7 days and can be used for testing for approximately two weeks. After two months, the sample's radiation level is returned to normal. The average sample used by Randy weighs less than a gram. Virtually all of the sample is retrieved after a test.

Randy Clarkson started testing gold recovery of sluiceboxes in 1988, at the request of the Klondike Placer Miners' Association in Whitehorse. Initially he used conventional methods which involved several people, D-9 Cats and huge volumes of water. The following year, Randy learned of a research method describing the use of nuclear tracers for similar tests. This method was improved and tested in Yukon goldfields in 1989. The results indicated that some operations were losing more gold than they were recovering, while other operations were operating extremely efficiently.

There is a definite ecological advantage when an operation is mining efficiently. Gravel tailings in the Dawson City area are sometimes reworked with the intention of finding gold not recovered by previous generations of placer operations. Reclamation is more likely to be successful if gold recovery is efficient and an area is deemed "mined out."



John Alton

Randy Clarkson working in Guyana.

MINING RESPONSIBLY: THE TIMES ARE CHANGING

At the beginning of the 21st century, the emerging mining industry is very different from that of even a decade ago. Environmental responsibility extends to all phases of the mining process, including exploration.

Exploration is carried out over extensive areas, yet less than 4 per cent of the Yukon land base may actually be staked. Often, many of those claims have no work done. Active mines occupy an even smaller area, less than 0.1 per cent of the Yukon land base.

Increased environmental awareness and improved technology have led many exploration companies to change their operations independently of government regulations.

There are more opportunities for community input through increased consultation and co-operative research ventures. Changes in legislation have significantly impacted reclamation practices in placer and hardrock mining.

Yukon government

Mining exploration site in the North Canol valley. Most mining camps now have "no-hunting" and "no-fishing" rules.

TECHNOLOGICAL IMPROVEMENTS

Technological improvements include larger helicopters and smaller diamond drilling equipment. Until the late 1960s, diamond drills could not be moved by air. Instead, they were dragged through the landscape, creating bulldozer access roads.

Now, with larger helicopters and lighter drill equipment, the "footprint" left behind from drilling has gone from hundreds of hectares (the whole length of a road) to a few square metres. The risks of erosion are significantly reduced.

Another positive technological change involves the use of excavators instead of bulldozers for trenching. New small excavators offer many advantages over bulldozers. When trenching with a bulldozer, material must be pushed downhill and out of the trench, which is as wide as the blade of the bulldozer. However, the small bucket of the excavator can make a much narrower cut. It can remove and set aside the topsoil and organic material, then dig deeper and pile the overburden (other soil and rocks) on the opposite side of the trench. When the trenching is complete, the different materials can be placed back in their original location. The area of disturbance is not much wider than the one metre width of the bucket, and the area will revegetate quickly because organic matter and roots are placed back at the surface.

The excavators have much lower bearing pressure than bulldozers and do not destroy as much vegetation. They can be dismantled and flown into remote exploration sites by helicopter, eliminating the need for access roads.

Diamond drillers are now much more careful about the drilling products they use. There is an effort to use drill mud with biodegradable additives rather than those that are petroleum-based.

Yukon exploration companies are also conscious of wildlife. If there is an area where sheep are lambing in early summer, it is left alone until later in the season. The same considerations are given during the fall caribou rut. Garbage is burned every night or taken out. Camps are moved by helicopter. Pilots are given strict instructions to avoid wildlife. Many camps prohibit hunting and fishing.

The growing use of Global Positioning System (GPS) units for surveying also reduces the disruptions on the ground. These small portable devices use satellite signals to provide a geographical position. This allows for more accurate locating of drilling sites and the need for fewer survey markers in the ground.

INCREASED COMMUNITY CONSULTATION

Exploration companies are consulting more with First Nations, communities, outfitters and other user groups to minimize or avoid conflicts wherever possible.

Industry, governments and First Nations are gaining a better understanding of each others' needs and concerns by forming partnerships and working together. It is important for companies operating in the Yukon to work with First Nation governments to ensure that the economic benefits of mineral development are shared. As well, partnerships make it possible for exploration and other industrial activities to occur in conjunction with traditional land use such as hunting, fishing and berrypicking.

There are 14 First Nations in the Yukon. Under the Umbrella Final Agreement, seven self-government agreements have been signed and negotiations continue. The resolution of land

Rod Hill

Whenever possible, smaller and lighter excavators are used to sample a placer deposit.

claims provides clarity and certainty for resource development. Land claims agreements encompass a broad range of topics: specialized training, scholarships, contracting opportunities, protection of traditional lifestyles and the environment.

Successful working relationships between a First Nation and a mining company have none-the-less occurred prior to the resolution of land claims. The following are some examples of joint ventures:

- The Tr'ondëk Hwëch'in Development Corporation, a First Nation company, built the access road to Viceroy Resource Corporation's Brewery Creek mine.
- The Ross River Dena Development Corporation was very involved in the mining sector at the Anvil Range mine in Faro and in the development of the Wolverine deposit.
- The Selkirk First Nation will see the first mining development on settlement lands in Canada. Minto Explorations Ltd. is developing a copper mine west of the Yukon River from Minto Landing. A socio-economic agreement with the First Nation provides employment and business opportunities at the mine.

CO-OPERATIVE RESEARCH VENTURES
The Mining Environment Research Group

The Mining Environment Research Group (MERG) is a co-operative working group established in 1998. It is made up of government agencies, mining companies, Yukon First Nations and non-government organizations to promote research into mining and environmental issues in the Yukon.

A summary of the research results commissioned by MERG is provided in non-technical language. This can then be used by a broad audience, including the general public, First Nations and communities.

MERG members work co-operatively in several areas:

- gathering information specific to the Yukon natural environment,
- identifying practises in mining activities to reduce adverse environmental effects,
- encouraging research to identify solutions to potential problems before there are negative environmental effects,
- providing the opportunity for exchange of information to benefit Yukoners and companies doing business here, and
- increasing confidence in environmental predictions for the opening, operation and closure of mining facilities in the Yukon.

Reports are available for viewing on the Economic Development web site (www.economicdevelopment.gov.yk.ca) and in all Yukon libraries. They are also available for purchase at the Map Publications desk, 667-3190.

Projects in 1998-99

- *Comparison of native vs non-native cyanide degrading bacteria for cyanide detoxification.*
- *Investigations into passive wetlands treatment of mine drainage to remove heavy metals at various sites at United Keno Hill Mine.*
- *Assessment of long-term vegetation and site conditions at reclaimed Yukon mineral and coal exploration sites.*
- *Methods of encouraging natural vegetation succession and sustainable reclamation at Yukon mine and mineral exploration sites.*
- *Adit ice plug prevention.*
- *Acid mine drainage kinetic testing.*
- *Winter low-flow stream measurements using the salt slug injection method.*
- *Faro tailings area down-hole geophysics program to study contaminant plumes.*
- *Natural attenuation of heavy minerals in soils downslope of mine adit, United Keno Hill Mine.*
- *Canadian standard for hardrock mine shallow slope decommissioning.*

Projects in 2000

- *Yukon placer deposits and water quality sampling program.*
- *Experimental reclamation project: establishment of shrub trial plots at Brewery Creek.*
- *Information brochure on cyanide.*
- *Assessment of low permeability covers as infiltration and oxygen barriers to reduce acid generation in mine tailings in the Yukon.*
- *Natural attenuation of heavy metals in shallow subsurface soils over permafrost downslope of Galkeno 300 Adit, United Keno Hill Mine.*

CURRENT LEGISLATION

As we have seen, there are a number of key federal and territorial pieces of legislation that directly apply to the mining industry in the Yukon. The following acts are likely to apply to all mine development projects:

- Yukon Placer Mining Act (federal)
- Yukon Quartz Mining Act (federal)
- Canadian Environmental Assessment Act (federal)
- Territorial Lands Act (federal)
- Yukon Waters Act (federal)
- Fisheries Act (federal)
- Yukon Mining Quartz/Placer Land Use Regulations (federal)

Another 17 sets of acts or regulations may apply to the mining process, depending on the size and type of mine planned. A complete list of the acts and regulations, with brief descriptions, is found in Appendix A.

PLACER MINING IN THE NEW MILLENNIUM

Increased environmental awareness has challenged the placer mining industry in the Yukon to meet ever better environmental standards.

Placer mining in the Yukon is now regulated by a dual permit process: a water licence and a mining land use permit.

Water licences

Water licences are issued by the Yukon Territory Water Board, and they serve the following purposes:

- set the allowable sediment discharge,
- limit the maximum rate of water use,
- restrict the type of mining in or adjacent to streams,
- require the settling or removal of suspended sediment in discharge water, and
- require the stabilization of tailings and stream channels.

Miners must provide detailed plans for diversions, drains, and the construction of settling ponds.

In order to manage streams and determine allowable discharges under the Yukon Placer Authorization, streams are classified into five types based on their sensitivity to water quality and their fish producing capability. (See chart below.)

When more than one mine is on a stream which requires protection, each of the mines has a lower allowable discharge standard. This ensures that their cumulative effect does not exceed the acceptable total sediment concentration.

Both the construction of new stream channels and the restoration of disturbed ones must meet specific guidelines to ensure that the new channels are stable during and after mining. Miners are encouraged to consider mining plans that do not involve disturbing existing streams. In current placer mining, there are many miners who are working on bench claims or in wide valleys away from the creek. They do not need to alter or divert the natural watercourse. Many of these operations

Stream classification

Class	Description	Management
I	sustain spawning and incubation of salmon, trout and char populations	requires habitat compensation for the disruption of important fish habitat before mining commences
II	may support rearing salmon, trout and char	
III	support other freshwater species, but are not associated with salmonoids	
IV	support past or present mining and are not seen to be important for the maintenance of fish populations	requires restoration of fish habitat
IVA	have fish (non-salmonoid)	
IVB	do not have fish	
V	unclassified (over 95% of Yukon streams). Little is known about their fish populations or placer mining potential.	must be assessed and classified to determine the level of habitat protection required before a mine can operate on it

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Evolving regulations

- late 1960s: Release of fine sediment from placer mines into adjacent creeks identified as an environmental concern.
- 1970: Discharge from placer mining first monitored after the establishment of the Yukon Territory Water Board (YTWB).
- 1986: Government and industry began developing regulations to protect fish and fish habitat, while giving the industry certainty in the form of clear guidelines to work within.
- 1988: Yukon Fisheries Protection Authorization (YFPA) established.
- 1993: Yukon Placer Authorization (YPA) established. The YPA is based on scientific principles to protect fish from the negative effects of placer sediment, and provide for the protection, compensation, restoration and alteration of fish habitat. YPA was also designed to meet the resource management requirements of the *Canadian Environmental Assessment Act* (CEAA) and the Final Umbrella Agreement of Yukon First Nations. Under YPA, placer miners are required to apply for a water licence from YTWB.
- 1999: Yukon Placer Mining Land Use Regulations (MLUR) came into effect to provide environmental screening and formal reclamation standards for all exploration and mining land use activities on placer claims and leases, including activities that may not require water licences.

have little or no discharge, and they recycle their processing water and remove sediment before re-use.

Mining land use permits

The objective of reclamation is to leave the land in the same condition of comparable utility for wildlife or humans as it was prior to disturbance, and where revegetation will occur naturally and rapidly.

Federal Placer Mining Land Use Regulations (MLUR) under the *Yukon Placer Mining Act* have formalized reclamation standards for all exploration and mining activities on placer claims and leases. All placer mining land use activities undergo environmental screening and receive comments from stakeholders prior to approval.

Tara Christie

This lake was created in 1991 by miners as part of the reclamation work. Moose frequent it to eat the weeds.

Guidelines are provided in MLUR for the following aspects of reclamation: re-contouring hillsides and banks, preventing long-term erosion, allowing for the re-establishment of the vegetative mat to prevent slumping and subsidence, and removing garbage and waste.

Placer exploration and mining activities are divided into four classes, based on increasing potential to have adverse effects on the environment. Classes consider the following criteria: area of overburden to be disturbed, volume of trenching, length of road or lines constructed, number of person-days per camp, and amount of fuel storage.

A project with a greater potential for adverse effects on the environment is considered under a higher class and receives more rigorous environmental screening.

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A project with a greater potential for adverse effects on the environment is considered under a higher class and receives more rigorous environmental screening.

The most important component of this new permitting process is planning. Operators can no longer leave reclamation of the land until the final stages of mining. In order for a placer mine to continue operation, mining inspectors from the Department of Indian and Northern Affairs must see on-going efforts at reclamation in accordance with the mining plan. The inspectors must also confirm that reclamation has been completed before the final abandonment of a property. On-going reclamation is more affordable and feasible. Well thought-out operating plans provide good protection for the environment and sound financial planning for placer miners.

Some placer miners have shown their commitment to the environment by the clean-up of garbage and scrap metal that has been abandoned by previous mining operations or residents.

Revegetation takes place rapidly in most placer-mined areas, particularly on old ponds, fine tailings and re-contoured overburden. Within one to two years, native plants and grasses usually form an initial ground cover on fine-grained surfaces.

Mike McDougall

Placer mining in the Sixtymile area; stripping in ice-rich permafrost soils, April, 1996.

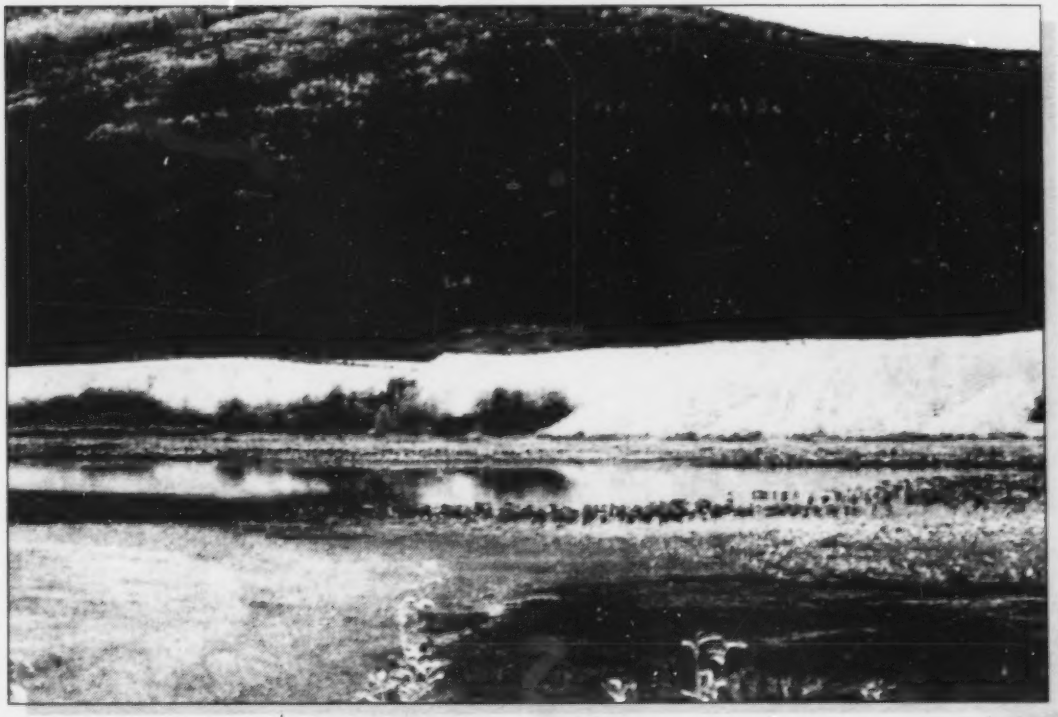
Mike McDougall

Same site, after reclamation, August, 1999.

Various types of willows are often the next shrub to grow in previously mined areas. These species provide a stabilized surface, prevent erosion and provide cover for wildlife within a very short period.

Depressions such as old ponds, reservoirs or reclaimed mining cuts often fill with water providing wetlands for ducks and migratory birds. Huge flocks of sandhill cranes on their migration south have been noted to rest and overnight on settling ponds and placer tailings.

The tender willows found in mining areas and tailing ponds are favoured locations for browsing moose.



Tara Christie

Tara Christie

These sandhill cranes flew overhead in the fall of 1999. They landed on settling ponds, reclaimed ponds and frozen tailings piles over at least a four-kilometre reach of the Lower Dominion Creek, near Dawson City (from the confluence of Gold Run to the confluence of Eureka).

MADE IN THE YUKON

The current regulatory regime to monitor land use and discharge by placer mining has been designed as a "made and administered in the Yukon" solution to meet the requirements for environmental screening and monitoring of mining under the *Canadian Environmental Assessment Act* (CEAA). Compliance with all regulations for placer mining is enforced by DIAND's Yukon placer inspectors. If you want to know more, please contact DIAND (Mining Land Use and Reclamation) or the Yukon Territory Water Board.

Mike McDougall

Mike McDougall

Bench during hydraulic stripping in 1986.
(inset) ***Same area in August 1991, five years after revegetation.***

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RECLAMATION

Division Mountain property

"When you design an exploration program with the idea of reclamation in mind, it is not as physically difficult or as expensive as you would think," said Rob Carne, an exploration geologist with 26 years of experience in the Yukon. Carne is a partner with Archer Cathro and Associates, an exploration consulting company which has operated in the Yukon for 33 years.

Carne is also the president of Cash Resources Ltd. He is in a good position to speak about the expense of reclamation on exploration projects. Cash Resources owns the Division Mountain property located about 90 kilometres northwest of Whitehorse. The property is estimated to contain 52.9 million tonnes of near surface, low sulphur thermal coal. Cash Resources worked on the project from 1992 to 1998.

If reclamation is not part of the exploration and planning process, it can be very expensive and difficult. From the beginning, the exploration program at Division Mountain was designed with reclamation in mind. "You can design your program to minimize the impact and the reclamation that will be required," said Carne.

Before Cash Resources built roads over areas underlain by permafrost, all the trees were cut with a chainsaw at ground level and removed. Every effort was made to preserve the ground cover vegetation so it would insulate the permafrost. "We have been driving on this road with pick-up trucks for three summers now and the permafrost is still there," said Carne, "because we took every care not to disturb the insulating moss mat."

In the case of temporary roads not underlain by permafrost, an excavator was used to put the moss, trees and shrubs back over the surface. This sheltered new grass, encouraged its growth and prevented access.

In another situation, trenches were dug on drier ground during the summer to find coal seams which tended to be located under two to three metres of glacial till.

"Carried out in conjunction with exploration, reclamation should add no more than five per cent to your budget," said Carne. "It makes sense financially, and it significantly reduces short-term and long-term impacts of exploration projects."

What about coal?

Seven sedimentary basins which host coal deposits have been identified but there has been limited exploration in many areas and reserve potential is unknown.

Large tonnage potential has been identified in the Bonnet Plume area in northeastern Yukon.

There has been growing interest in thermal coal at Division Mountain, a Cash Resources project near Whitehorse, where the capacity for significant tonnage was recently recognized. This deposit has the potential to fuel a growing local industrial power demand and meet the requirements of Asian markets.

Jeff Bond

Working to keep the land as undisturbed as possible.

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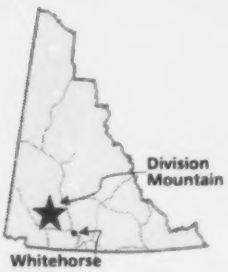

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MINING RESPONSIBLY

As society has become more environmentally aware, so has the mining industry

by Hugh Copland, Engineer of Mines, Mining Development, DIAND

Mining and the environment are often seen as opposites. But as society has evolved into a more environmentally aware community, so has the mineral industry. The situation in the Yukon is no exception.

Exploration and mining activities in the territory are permitted and monitored by the federal government. At the exploration stage, activities are governed by the mining land use regulations under the *Yukon Quartz Mining Act*. This legislation ensures that environmental disturbances created by mining exploration activities are minimal and any adverse impacts are dealt with.

Increased use of helicopters and other advanced geophysical technologies ensures that mining activities leave a negligible impact. Indeed, significant ore deposits have sometimes been located without anybody ever having set foot on the ground.

Companies that wish to construct a mine go through a rigorous assessment procedure under the *Canadian Environmental Assessment Act*. First, baseline studies are undertaken to collect information on the natural characteristics of the general area. These include water quality, fisheries, wildlife, vegetation and traditional land uses. Baseline studies are important because they help determine the effects a mine may have on the environment once it is operational.

An environmental review committee, comprised of First Nations and federal and territorial governments, then examines the information. Public meetings are often held in communities closest to the project. The mine will only proceed to the licensing stage after the environmental review committee has reviewed the baseline studies and mine plans, and the federal government is satisfied that environmental effects will be mitigated.

An important part of the environmental assessment is the abandonment and reclamation plan submitted by the mining company. This plan sets out how the land will be restored after the mine shuts down.

The preferred solution of both mining companies and the public is a "walk away" scenario, where the land is revegetated and no further maintenance is required. In some cases, mining companies, nearby communities, First Nations, and traditional land users may wish to develop reclamation plans that allow for a different use of the land.

For example, the City of Whitehorse has been using abandoned open pits from the old Whitehorse copper mine as landfill sites for a number of years.

Improved wildlife habitats, recreational opportunities or other industrial uses are all feasible post-mining land use options.

Monkshood.

Lee Pigage

The fragility of the northern environment makes mining and reclamation an even more challenging aspect of mine planning in the Yukon. Proven southern procedures may not necessarily be a panacea in the north. For example, the heap leach process is common in the southwestern United States and in South America. In the Yukon, the Brewery Creek mine is the northernmost heap leach operation in Canada. Here, extreme winter temperatures have necessitated several design changes compared with southern heap leach pads.

The delicate balance between environmental protection and utilization of natural resources is always a challenge, especially for operators in the north who are continuously overcoming difficulties. With innovative thinking, technological advancement and an open dialogue between companies, government and the public, mining can maintain a balance with the environment that benefits all northerners.

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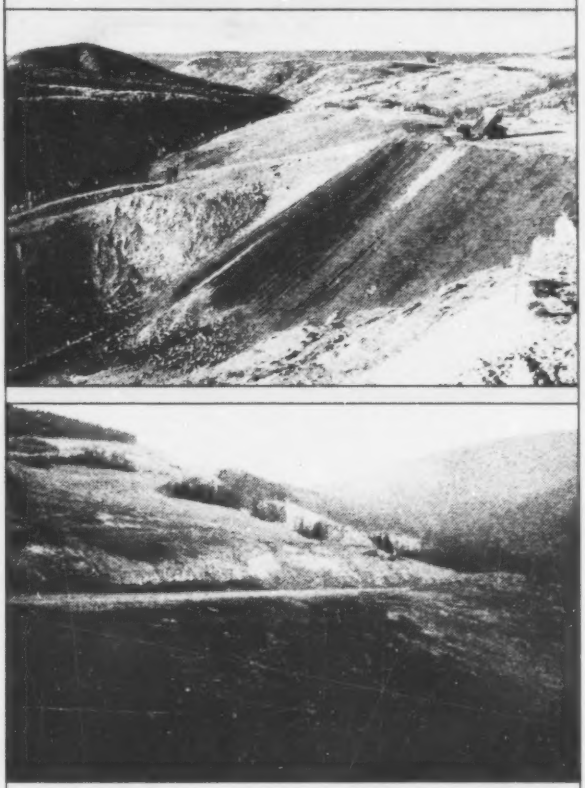
awarded by the Department of Indian and Northern Affairs

This award recognizes reclamation and site restoration efforts that go well beyond what is required by law. This may be achieved by companies reclaiming land for which they had no obligation to reclaim; adding features to the land that enhance the area and local community; or returning mined land to a condition that is sound and aesthetically pleasing.

1999 WINNERS

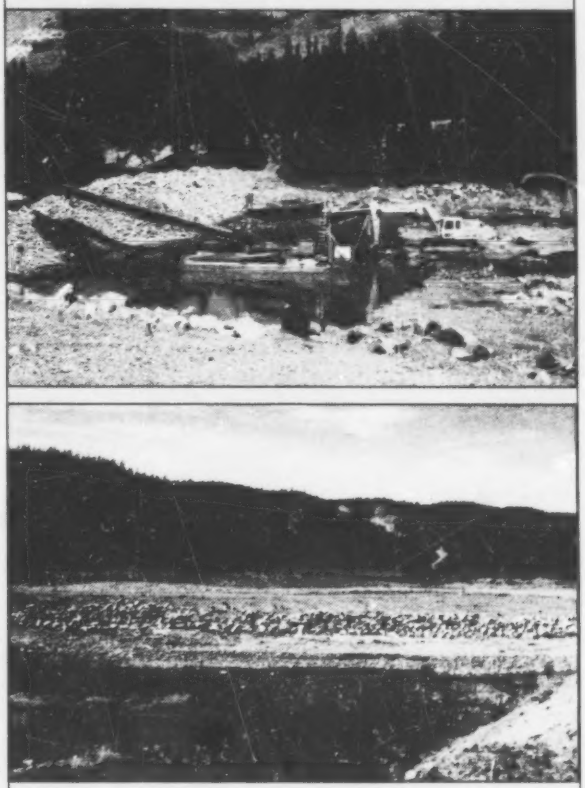
HARDROCK MINING AWARD



Canadian Zone.** (top) **Active mining operations waste dump, 1997.** (bottom) **Beginning of revegetation, 1999.

Viceroy Resource Corporation has been doing on-going reclamation work on the Brewery Creek gold mine near Dawson City. From its inception, Viceroy has involved community and First Nations in the development and reclamation plans for the mine site. The first reclaimed pit is a credit to the research and planning that went into leaving the mined lands in a state that fits naturally into the surrounding valley. Restoration is a staged, on-going process and to date, most of the company's first pit and waste dump has been reclaimed.

PLACER MINING AWARD



Tic Exploration.** (top) **Floating dredge operation.** (bottom) **After reclamation, prior to natural revegetation.

Tic Exploration has been recognized for its placer mining reclamation practices on Gladstone Creek. Miner, Al Dendys, uses two floating trommels and wash plants. The large-scale disturbance resulting from an operation of this size has been mitigated by excellent restoration work done quickly after extraction of the ore. Immediately the tailings are levelled, re-contoured and covered with fine material stockpiled during the preparation of the mining cut. To date, this is the finest example of progressive restoration work in the Whitehorse Mining District.

ROBERT E. LECKIE AWARD FOR OUTSTANDING RECLAMATION PRACTICES

awarded by the Department of Indian and Northern Affairs

This award recognizes reclamation and site restoration efforts that go well beyond what is required by law. This may be achieved by companies reclaiming land for which they had no obligation to reclaim; adding features to the land that enhance the area and local community; or returning mined land to a condition that is sound and aesthetically pleasing.

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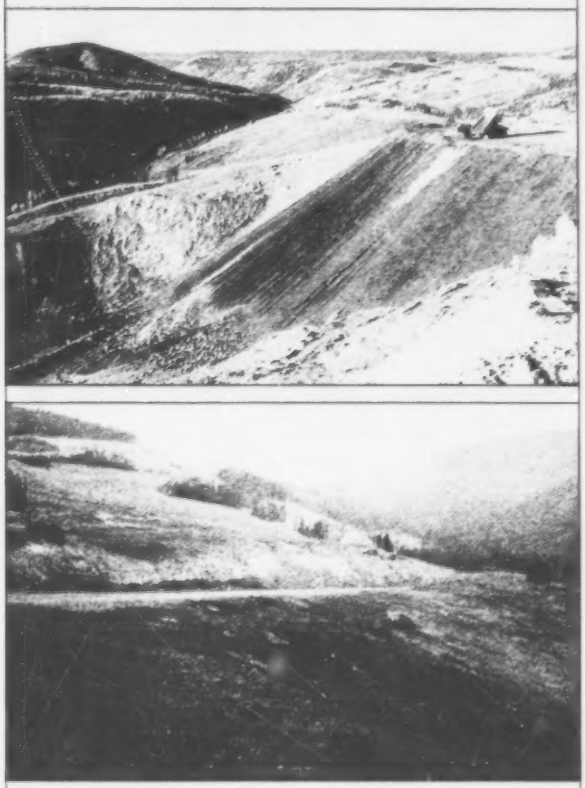

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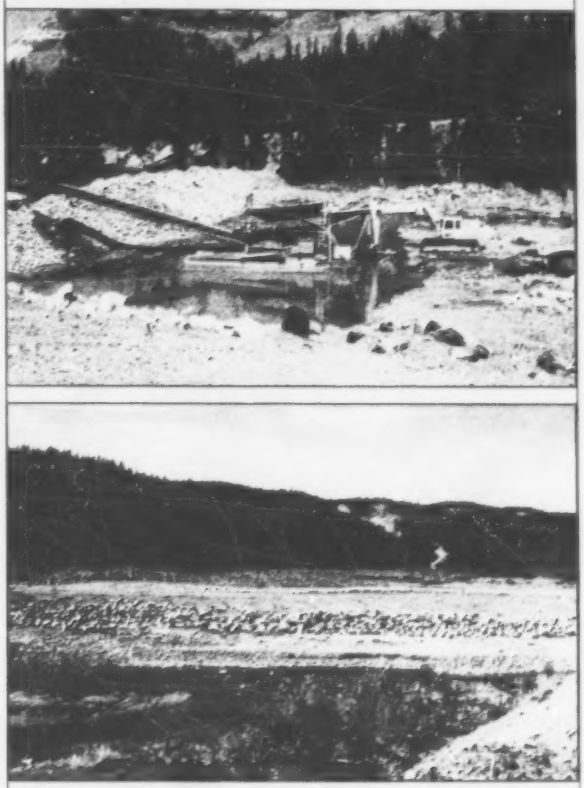

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2000 WINNERS

HARDROCK MINING AWARD

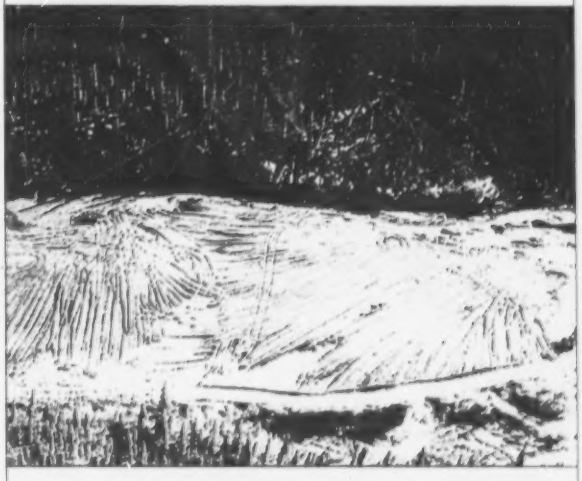
Walking a backhoe across the tundra to the Killer Gold property, Killerman Lake.

Cash Resources Ltd. conducted outstanding exploration and reclamation work in 1995 on the Killer Gold property, located approximately 45 kilometres northwest of Haines Junction.

Twenty-six kilometres of cross country trekking was required to mobilize a back hoe onto the claim. Extra care and expense was taken to ensure that the route would not be re-useable or visible. The work schedule was carefully planned to minimize impact on sheep. The company also partially funded a study to document the effects of the exploration program on sheep habitat. Exploration trenches were carefully restored to ensure natural revegetation, drill pads were built by hand, and the camp was completely removed at the end of the program.

Cash Resources Ltd. had continuously strived to achieve excellence in its reclamation practices long before the legislated requirement to do so. The company has also fostered good relationships with the communities near its exploration activity.

PLACER MINING AWARD



Contoured tailings at Hunker Creek are covered with "black muck" to enhance natural revegetation.

Grew Creek Ventures Ltd. has a property on Hunker Creek where Dave Marstars has been placer mining since 1998. This property has been mined by other placer miners since the turn of the century, however, it has never previously been reclaimed.

Reclamation work during 1999 and 2000 included cleaning up abandoned debris and waste petroleum products from previous miners; contouring tailings from the current operation and all previous operations to a gentler topography; and spreading black muck over the contoured tailings to promote rapid re-vegetation.

In addition, a wide, stable stream channel was established and small out-of-stream ponds were created to enhance the local habitat.

This operation provides an exceptional example of corporate stewardship of the land. The effects of over a century of mining will not be recognizable thanks to the efforts of Grew Creek Ventures Ltd.

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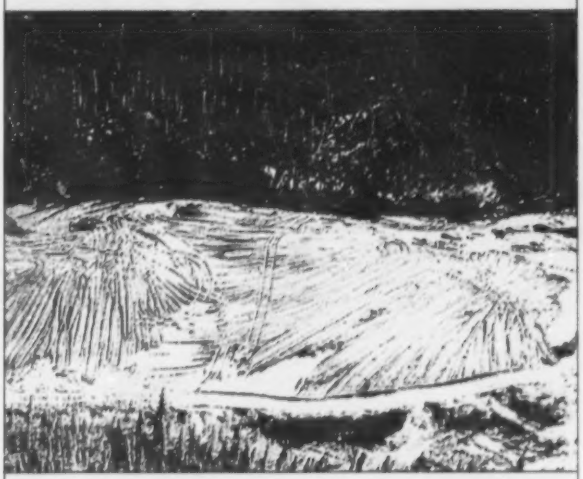

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ACID ROCK DRAINAGE

Acid rock drainage (ARD) is a natural phenomena which has taken place for millions of years. It occurs when sulphide-bearing rocks are exposed to water and air, producing sulphuric acid.

Where does it occur in the Yukon?

Acid rock drainage develops naturally in the MacMillan Pass, Clear Lake in the Pelly River Basin, and Engineer Creek along the Dempster Highway.

What does it look like?

When ARD is neutralized by natural buffering minerals, the metals precipitate out of the water and form deposits on the stream bottom, or stains on the rocks. Typically these are iron hydroxides, which are bright rusty-red to orange in colour. Copper carbonates have blue, turquoise, or green precipitates.

Names of watercourses on topographic maps may indicate ARD: Ironrust Creek, Red Springs, Red Gulch, and Rusty Creek.

Can mining cause acid rock drainage?

The mining process exposes mine wastes, tailings, or mine workings that sometimes contain sulphides in sufficient quantities to result in acid generation. More surface area is exposed to react with air or water. Some bacteria can increase the rate of acid generation. This process is often referred to as acid mine drainage (AMD).

What problems can acid rock drainage cause?

Acidic water can dissolve metals from the rocks and sediments over which it flows. The main metals of concern in the Yukon are zinc and copper. Some animal species are more tolerant to these metals than others. Animals such as certain insect larvae (mayflies) and salmonoid fishes will be absent from water with elevated levels of metals. Plants can also be stressed from exposure to ARD. This results in stunted, sparse growth, or discoloured leaves.

How can we stop ARD?

If all moisture or oxygen were removed from the sulphide-bearing rock, acid generation would stop. Reducing some bacterial activity would also decrease the rate of acid generation. There are expensive and complex procedures to restrict this contact: permanent flooding of tailings areas and pits; sealing waste rock piles with impermeable covers; and the operation of water treatment plants.

The prevention of ARD at mine sites is more cost effective than the control, collection, and treatment of contaminated water once it arises. The best defense in dealing with AMD is based on prediction and prevention.

Is ARD a problem in the Yukon?

Like other mining regions in Canada, ARD is the most significant issue facing the mining industry in the Yukon. Abandoned mines can continue to generate acid drainage long after operation. Some mining areas in the Yukon have very little or no potential of acid rock drainage, mainly due to the buffering capacity of the host rock. Developing mines are now required to test for the potential of acid generation.

Lee Pigage

Impacts on water and fish habitat quality are part of the environmental studies undertaken.

BIOREMEDIATION: CLEANING UP WITH WETLANDS

Bioremediation is the process of using organisms, including plants and bacteria, to break down and get rid of contaminants. Wetlands act as store houses and purifiers of water, and they provide valuable habitat for waterfowl and other organisms. A natural process cleans up a human-made problem.

What is a wetland?

A wetland occurs at the contact between drier uplands and adjacent water, where the watertable is at or near the surface.

What do wetlands treat?

Wetlands have been used for decades in many parts of the world for the treatment of municipal wastewater (sewage). They significantly reduce sediments, oxygen-demanding substances such as ammonia, and nutrients such as nitrogen and phosphorus. Applications have expanded to include treatment for industrial wastewater.

Can wetlands help treat acid mine drainage?

Yes! Since the 1980s, wetlands have been used in the treatment of acid mine drainage, usually at coal mines. There are a number of examples of natural wetlands used to treat mine waste water in Canada.

- At Silver Queen mine in Smithers, B.C., the wetland receives and treats zinc-contaminated discharges.
- At the Miramar Con Operations, Great Slave Lake, NWT, arsenic, copper and cyanide in the water are reduced as they pass through a series of lakes and muskeg before being discharged into Great Slave Lake.

How do wetlands work?

Soil is one of the most important physical components of a wetland, and it plays a direct role in the removal of metals. Clay is capable of adsorbing metals; organic soils offer little or no potential for the removal of metals. The soils must also support wetland vegetation.

Vegetation plays an indirect role in the removal of metals. Rooted vegetation (i.e. sedges) is used in the Yukon. The roots hold the substrate together, prevent channels from forming, and increase residence time of water in the wetland. The plants also produce detritus which provides habitat and organic matter required by bacteria. As the bacteria decompose the organic matter, anaerobic (without oxygen) conditions allow for some chemical reactions to take place, which increases the alkalinity of the water. The alkalinity neutralizes acid mine drainage, and various metals can precipitate out.

Wetland plant species vary in their ability to accumulate metals. Some may have elevated tissue concentrations while others show little accumulation.

Natural vs constructed wetlands?

Natural wetlands aren't always there when you need them. Sometimes there is a need to design and construct wetlands. This is a lengthy process: one to two years of planning, and a time for the plants to establish in the wetlands before contaminated water is introduced. Wastewater then must be in the wetland system a sufficient time for the biological (microbial), chemical (reduction, oxidation), and physical (sorption) activities to occur.

Will constructed wetlands work in the Yukon's colder climate?

Most of the wetland treatment systems have been designed and used in temperate climatic areas where permafrost, extreme minimum temperatures, and limited plant productivity is not a great concern.

A pilot wetland was constructed in 1995 at the United Keno Hill Mine property to help answer this question. After one season of wetland treatment, initial results showed that the pilot wetland significantly reduced zinc concentrations. Four years later, the wetland was still in existence and supported healthy growth of the transplanted sedges.

BREWERY CREEK: A CASE STUDY

Brewery Creek is different from other traditional hardrock mines in the Yukon because it uses the heap leach process to separate the gold from the rock. This allows the efficient and economic extraction of gold from deposits with a lower gold content and also cuts down significantly on the amount of energy required to extract and transport ore.

At Viceroy Resource Corporation's Brewery Creek mine, the ore is extracted from a series of small to medium-sized open pits instead of one very large excavation. Gold deposits have been found in at least eight different zones and several other exploration targets exist for potential additional reserves.

The host rock in which most of the gold is found is called limonitic-altered quartz monzonite. The upper 30 to 40 metres of rock have been severely weathered over the last thousands of years. This rock, which crumbles easily, has been preserved because the area has not been glaciated in the last two million years.

The gold is part of the chemical composition of pyrite (iron-rich) crystals, from which the gold cannot be fully recovered. Oxidation (weathering) breaks down the pyrite crystals and frees the gold from the original rock. This allows the gold to be separated by the heap leach process and collected as a separate gold-rich solution.

HOW THE HEAP LEACH PAD WORKS

At Brewery Creek, ore has been placed to form a 30-metre high leach pad. A dilute cyanide solution is dripped from perforated plastic pipes about a metre apart onto the ore. The cyanide solution percolates through the rock, dissolves the gold, and carries it down through the heap.

Yukon government

Heap leach pad and plant at Brewery Creek mine, 1997. As of March, 2001, Brewery Creek was the only operating mine in the Yukon.

Caustic soda is mixed into the solution to maintain a high pH, which keeps the cyanide from evaporating. Lime is also added to the ore when it is placed on the leach pad.

At the bottom of the heap are two composite liners of plastic and compacted silt. This prevents any fluid from escaping. Above the top liner is a series of pipes that collect the solution and, with the help of gravity, transport it to a plant. This is a completely closed system so none of the solution is discharged into the environment. The gold-rich solution from the pad goes into the plant where the gold is recovered.

The heap solutions are warmed with exhaust gases captured from a waste oil burner and generator. Heating the solution allows leaching of ore to continue though winter temperatures as low as -50° Celsius. Ore loading on the heap is restricted to warmer months so that pockets of permanently frozen ore will not form within the heap.

The gold-rich cyanide solution is passed through the adsorption/desorption recovery plant where the gold is extracted with the use of carbon, a by-product of burned coconut shells. Smelting into gold bullion occurs on site. The solution is then reconcentrated with caustic and cyanide, and circulated back to the pad.

Yukon government

Eleanor Van Bibber, first gold pour ceremony, Brewery Creek.

Yukon government

Drip lines are part of the leach pad at the Brewery Creek Mine, 1997.

Safety measures ensure no leakage

The site originally proposed for the Brewery Creek pad had lots of permafrost. This was a concern. Another site was selected to eliminate the risk of ground instability due to thawing permafrost.

Underneath the pad, two layers of plastic made up of one-millimetre thick, durable, puncture resistant, non-reactive PVC completely isolate the pad from the underlying surface. Beneath each PVC liner is a 30-centimetre layer of compacted silt. Between the liners, in a layer of gravel, is a leak-detection piping system. Solution getting past the first layer will show up in the piping system.

Brewery Creek's double liner system is not common among heap leach pads. Given the extreme conditions of the north, different design criteria had to be followed. A rigorous permitting process resulted in the design specifications for construction of the pad exceeding the industry standard in the south.

Monitoring

On a quarterly basis, ground wells surrounding the lower extent of the leach pad are monitored to detect possible cyanide escaping into the environment. Nearby creeks are sampled on a monthly basis.

The heap leach pad

New sections, or cells, of fresh ore are constantly added to the pad. In a few years, a treatment facility will be built to wash spent ore from the first cells. The water used will be treated before discharge. If extreme precipitation causes the amount of solution coming off the pads to become greater than the processing plant can handle, the solution is diverted into one of two ponds. These ponds are also double-lined and equipped with leak detection piping.

An additional overflow pond has been designed for a complete drain down of the leach pads, the processing plant and a one-in-100-year snowpack accumulation. Even in that unlikely scenario, everything would remain contained.

In the future, Viceroy Resource Corporation plans to start the detoxification of some of the ore on the leach pad. Large amounts of rinsing water will be circulated through a section of the pad and collected at the bottom to be treated. Once the rinsing water meets required standards, the ore will be left where it sits and reclaimed. Most of the side slopes will be recontoured, seeded and fertilized.

Don Murphy

Kokanee zone at the Brewery Creek mine. The weathered rock is mined and processed.

M121

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RECLAMATION

At the Brewery Creek mine, the reclamation of waste rock, mined-out pits and used ore is an on-going process. The people involved with reclamation — including the environmental coordinator, the environmental technician and the operations staff — feel fortunate that the ore deposits are being mined from a series of relatively small pits instead of one large area. It is easier for reclamation to be on-going, instead of being delayed until most or all of the mining is completed.

The sequential mining of a number of ore reserves allows the backfilling of one pit with the waste rock from the next. Backfilling is the preferred method because it causes less site disturbance and the pit walls end up recontoured, allowing the area to blend into the original landscape.

At Brewery Creek, over 70 per cent of the mine waste rock will be disposed of in mine pits. The first pit mined was the Upper Foster's. Because it is smaller than the second reserve, Canadian, a waste rock dump had to be constructed adjacent to the larger pit. Some material from Canadian was also used in the construction of a haul road.

The first step in reclaiming waste rock is to recontour the slopes with heavy equipment until a stable, gentler slope is achieved. Then "growth media," the north's version of topsoil, is spread over the gentler slopes. Seeding, fertilizing, and monitoring of the vegetation growth follow.

Viceroy Resource Corporation

In 1997, Viceroy Resource Corporation was named the environmental leader of the Canadian mining industry by the Social Investment Organization of Canada, a non-profit organization formed in 1989 to promote socially and environmentally responsible investment. The high environmental standards that Viceroy demonstrated in design, startup and operation will also be applied to mine decommissioning.

The Canadian waste rock dump was recontoured, seeded and fertilized in 1997. The environmental staff is monitoring the area to see what native plants naturally come in on their own. Poplar, wild rose, and lupine commonly colonize disturbed areas. The company also tried to seed native grass species similar to those found locally. Recently, it has involved school students in a research project to test the successful replanting of local shrub species.

The on-going process of reclamation has become a routine part of mining at Brewery Creek. The mine operations group works the recontouring in with all their other tasks. Mine planners are thinking ahead to the very end product. It saves time and money and makes reclamation and the abandonment plan environmentally and financially sensible.

Waste rock at Brewery Creek is smoothed, recontoured and seeded. In a few seasons, natural vegetation will colonize the disturbed areas.

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William LeBarge

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CYANIDE

Cyanide is probably the most universally recognized poison, with the possible exception of arsenic. It is produced in nature by a wide range of organisms, bacteria, fungi, and approximately 2,650 plant species.

Some centipedes, millipedes, insects, beetles, moths, and butterflies secrete cyanide to repel predators such as toads and birds.

Some of the common plants that contain cyanide are almonds, kale, lettuce, broccoli, cauliflower, corn, sweet potatoes, and the pits or seeds of cherries, plums, apricots, pears and apples.

Cyanide can also be human-made. It is manufactured from ammonia and natural gas and is also a by-product of the manufacture of acrylic fibres and plastics.

What forms does cyanide take?

Cyanide occurs in many forms. The form most used in mining is sodium cyanide. When it is mixed with water, the pH must be kept above 11 or the poisonous gas, hydrogen cyanide, results.

Strict safety procedures are followed when transporting, storing and handling cyanide products.

How is cyanide used?

Cyanide is a common ingredient in the following products and processes:

- synthetic blue dye (blue jeans),
- fumigant and poison,
- manufacture of nylon, plastic, glass, perfume, soap, fertilizer, paint, animal food and pharmaceuticals,
- surgical dressings,
- anti-cancer preparations,
- drugs to reduce high blood pressure, and
- electroplating (silver and gold plated dinnerware, brass plated bathroom fixtures).

The most familiar use of cyanide is in the mining industry. In Canada, over 90% of the gold mined is extracted using a cyanidation process. Cyanide has been used since 1887 to extract gold, silver, copper, zinc, and molybdenum from ore. It allows for the economical recovery of microscopic metals from low grade ore.

Where has cyanide been used in the Yukon?

In the past, cyanide has been used in mills at the Faro, United Keno Hill, Mt. Nansen, Mt. Skukum, Ketza River, Venus, Arctic Gold & Silver, and Sa Dena Hes minesites. Cyanide is currently used in the heap leaching process at Brewery Creek.

What is done with the waste cyanide and abandoned heap leach pads?

Cyanide can be destroyed, degraded, or detoxified by physical, biological and chemical processes. Some of these processes occur naturally and are called natural degradation.

Prior to the mid-1970s, natural degradation was the only treatment for cyanide in tailings ponds. This method did not work during winter under ice cover, nor did it deal with all forms of cyanide.

Chemical processes are very expensive.

Biological alternatives, using several species of bacteria, are now being studied.

Current research

Good news! A 2000 Yukon MERG (Mining Environment Research Group) study has shown that cyanide-degrading bacteria are naturally abundant in soils at the Brewery Creek Mine site. The bacteria are able to successfully work in our colder climate to bio-degrade cyanide on a processed ore heap. This method is more efficient and economical than conventional chemical processes. More studies were recommended.

We are in daily contact with cyanide through the foods we eat and the products we use. With proper handling, care, and disposal methods, we will not harm ourselves or our environment.

Danièle Héon

Strange things are done in the land of the midnight sun. (Robert Service)

APPENDICES

APPENDIX A. Acts and regulations pertaining to mining in the Yukon

- *Yukon Placer Mining Act* (federal) allows the staking of placer claims and leases.
- *Yukon Quartz Mining Act* (federal) allows the staking of mineral claims.
- *Canadian Environmental Assessment Act* (federal) requires an environmental impact assessment as well as a review of development projects that require federal approval, federal funding or federal disposition of land.
- *Territorial Lands Act* (federal) regulates land use activities. This act does not apply to mineral claims but will apply to the building or maintenance of access roads to mineral properties.
- *Yukon Waters Act* (federal) regulates water usage and controls the deposition of waste into Yukon waters, bridge and stream crossing. Provisions in water licences often contain requirements related to the land, such as measures to stabilize waste dumps. The Yukon Territory Water Board is responsible for issuing water licences.
- *Fisheries Act* (federal) provides for the protection of fish habitat and alteration, destruction or disruption of fish and fish habitat, including the regulation of stream crossings.
- *Yukon Mining Quartz/Placer Land Use Regulations* (federal) regulate the disturbances left by exploration programs and placer mining activities. Camp cleanliness and reclamation of trenches or mining cuts, roads and drillpads are mandatory and must comply with the regulations.

Depending on the size and type of the mine planned, the following regulations may apply or the following permits may be needed.

- Activity in areas identified or known to have special wildlife habitat values: permit issued under Section 4 of the *Wildlife Area Regulations* (federal). Environmental assessment is required.
- Activity in a migratory bird sanctuary: permit issued under the *Migratory Bird Sanctuary Regulations* (federal). Environmental assessment is required.
- Building or work such as bridges, dams, boom or causeway in, on, over, through or across any navigable water: the *Navigable Waters Protection Act* (federal) regulates such activities.
- Regulating permits issued for the storage or use of explosives: the *Explosive Act* (federal).
- Approval to use, possess or import prescribed substance devices such as analyzers, chromatographs, calibrators, fixed and portable gauges, industrial radiography, logging, detectors, etc.: radioisotope licence issued under the *Atomic Energy Control Act* and subject to the *Atomic Energy Control Regulations* (federal). Environmental assessment may be required depending on the criteria listed in the *Canadian Environmental Assessment Act*.
- Approval to burn refuse: burning permit issued from April to September under the *Yukon Forest Protection Act* (territorial). Environmental impact assessment is required.
- Approval to construct highway access: permit issued under the *Yukon Highway Act* (territorial) which includes conditions regarding construction standards and gives permission to carry out construction.
- Oversize trucking (concentrate hauling): *Bulk Haul Regulations* (territorial).
- Archaeological, palaeontological and historic site investigations in the field by an archaeologist: archaeological research permit issued under the *Yukon Archaeological Sites Regulations, Yukon Act* (territorial).
- Fish and wildlife research and surveys: *Fish and Wildlife Research Permit* (territorial).
- Aerial moose or caribou survey: *Sundry Permit under the Wildlife Act* (territorial).
- Permit for fuel storage and handling and registration of stationary fuel tanks greater than 4,000 litres: special waste regulations under the *Environmental Protection Act* (territorial).
- Operation of a diesel engine underground: permit issued under the *Blasting Regulations* (territorial).
- Installation of plumbing in the camp: plumbing permit under the *Canadian Building Code, Building Standard Act and Regulations* (federal).
- Building permit for areas not included in municipal bylaws: building permits must meet criteria under the *National Building Code of Canada, Building Standard Act and Regulations* (federal).
- Electrical approval: electrical permit must meet *Canadian Electrical Code, Electrical Protections Act and Regulations* (federal).
- Mixing and dilution, generation, handling, release or disposal of large quantities of special wastes: special waste permit issued under the *Environment Act* (territorial).

APPENDIX B. Glossary

accrete: The process of colliding tectonic plates.

acid mine drainage (AMD): Essentially the same as acid rock drainage, although a greater surface area of sulphide rock is exposed to oxygen and water through mining activities.

acid rock drainage (ARD): Natural or human related process that results in chemical changes or oxidation of rock. Water with a lower pH draining over sulphide rock will dissolve metals in the rock. The three necessary components of acid rock drainage are oxygen, water and sulphide bearing ore.

adit: An opening driven horizontally into the side of a mountain to provide access to a mineral deposit.

alloy: A compound of two or more metals.

assay: To confirm the percentage of a metal in a sample. This is expressed as grams/tonne, ounces/ton, ppm (parts per million) or ppb (parts per billion). If the percentage of metal in a sample is very high, it may be expressed as a per cent (%).

benthic invertebrates: Invertebrates (organisms without a backbone) that live in the substrate of a watercourse.

bioremediation: The process of using organisms, including plants and bacteria, to break down and get rid of contaminants.

breccia: A type of rock in which angular fragments are imbedded in fine grain sediments.

claim: Land held by a prospector or mining company. In Canada, a claim is typically 16 hectares (40 acres).

commodity: Usually refers to a raw material or primary product, such as copper, gold, coffee, sugar and cotton, that is traded on the free market.

concentrate: A fine, powdery product of the milling process containing a high percentage of valuable metal.

craton: Very old, underlying, stable rock of the Canadian Shield.

exploration: The finding of new ore or mineral deposits. There are two types of exploration. Surface exploration does not alter the landscape. Underground exploration removes rock and can disturb the landscape.

gross domestic product (GDP): The value of all goods and services produced in the economy during a given time period.

hardrock mining: A process that requires crushing and processing of rock to separate valuable minerals from the rock.

heap leach: A method of separating valuable metals (usually gold) from an ore heap on a pad. A diluted sodium cyanide solution is percolated through the ore and the metal rich solution is collected at the bottom of the pad.

high grade: An ore deposit near the surface with a high content of valuable metals.

lava: Molten rock extruded upon the earth's surface.

low grade: A less concentrated or more dispersed ore deposit that is expensive to extract.

metal: A compound or element with definite physical properties and chemical composition. Gold, silver, copper, lead and zinc are examples of metals.

mill: A processing plant in which minerals are recovered from the ore.

mineral: A naturally occuring compound or element with definite physical properties and chemical composition and, if formed under favourable conditions, a definite crystal form. Minerals can contain important metals that are mined as resources.

mitigation: An attempt to reduce damages to the environment.

ore, ore body, ore deposit: A mixture of economically valuable metals and worthless minerals from which at least one metal can be extracted at a profit.

placer mining: The process of using water and gravity to separate heavier metals such as nuggets or flakes of gold from the surface.

pluton: Rock of igneous origin that was implaced at some depth in the earth's crust. It may be exposed at the surface by erosion.

rock: Aggregates of two or more minerals.

sluice: The process of allowing gold to settle out while washing away gravel, sand and clay with water.

smelt: The use of heat and energy to extract the metals from the minerals.

reclamation: The restoration of a site after mining or exploration is completed.

refining: The final preparation of metals before manufacture.

stakeholder: An invested interest in a mine property.

sulphide: Minerals that combine with sulphur (S), for example, galena (PbS) and pyrite (FeS).

tailings: The material rejected after the valuable minerals have been extracted from the ore. The tailings are the fine particles collected in the tailings ponds.

terrane: Any rock formation or series of formations bounded by faults and distinct from surrounding rocks.

waste rock: Rock with a low content of valuable minerals. It is usually heaped in piles.

APPENDIX C. Mineral Resources

The Mineral Resources Branch of Economic Development, Government of the Yukon, does the following for the exploration and mining community:

- administers the Yukon Geology Program in partnership with DIAND.
- maintains an extensive database of Yukon mining and exploration projects.
- provides funding to individuals, partnerships and junior mining companies through the Yukon Mining Incentives Program.
- provides information to potential investors on the Yukon's mineral potential and mining investment opportunities.
- assists exploration and mining companies in the regulatory process by providing advice on contacts, processes and timing requirements.
- disseminates information about the geology of the Yukon and the Yukon's exploration and mining industry by attending trade shows and mining conferences.
- provides technical expertise on behalf of the Yukon government on regulatory review committees and working groups.
- provides information about the Yukon's mineral resources through the Department of Economic Development website.
- provides information on mining taxation, including the Yukon Mineral Exploration Tax Credit.

Information is available from: Jesse Duke, Yukon Mining Facilitator, phone: (867) 667-3422 or 1-800-661-0408, jesse.duke@gov.yk.ca

PROGRAMS

The Yukon government currently offers a program to encourage the development of the Yukon's mineral and energy resources: the Yukon Mining Incentives Program (YMIP). In addition, the government offers the Yukon Mineral Exploration Tax Credit which provides a 25 per cent refundable tax credit until March 31, 2002. Combined, these initiatives ensure that the Yukon offers one of the best incentive programs in Canada.

Information on the Yukon Mineral Exploration Tax Credit is available from: Department of Finance phone (867) 667-3074.

Yukon Mining Incentives Program

This program is designed to promote and enhance mineral prospecting, exploration and development activities in the Yukon, providing a portion of the risk capital required to locate and explore mineral deposits. Grassroots programs (prospecting and grubstake categories) are conducted on open ground (crown land). Target evaluation programs are conducted on newly discovered prospects and projects covered by mineral claims, placer prospecting leases and claims, and coal licences and leases. Technical assistance is offered to the industry, upon request, by the Yukon Geology Program staff. The Yukon government has increased funding by $250,000 to a total of $628,000 for this program.

Information is available from: Ken Galambos, Mineral Development Geologist, phone (867) 667-5996 or 1-800-661-0408, ken.galambos@gov.yk.ca.

REFERENCES

Economic Development

Yukon Mineral Exploration Tax Credit Bulletin.

Yukon Annual Statistical Review.

Yukon Exploration and Geology, Yukon Geology Program, January, 2001

Yukon Mineral Property Update, January, 2001, 67 pages.

Yukon Mineral Deposits, January, 2001

Yukon Short-term Economic Outlook 2001.

To order:
Economic Development
Suite 400-211 Main Street
Box 2703
Whitehorse, Yukon Y1A 2C6
phone (867) 667-5466 or 1-800-661-0408
fax (867) 667-8601

Yukon Geology Program

Publications List, January, 2001 (updated every couple months). Includes lists of federal and territorial reports and maps on the regional bedrock mapping, mineral deposits, placer deposits, mineral assessment, gemstone exploration, geochemical, geophysical and environmental studies.

To order:
DIAND Publications Desk
phone (867) 667-3266
fax (867) 667-3267

Mineral Resources Directorate

A guide to services in the Yukon, 1999.

To order:
Mineral Directorate
Indian and Northern Affairs Canada, Yukon Region
phone (867) 667-3251

Environment Directorate

Permit guide for projects in the Yukon, November 1998.

To order:
Environment Directorate
Indian and Northern Affairs Canada, Yukon Region
phone (867) 667-3126

Web sites

Economic Development
www.economicdevelopment.gov.yk.ca

Yukon Geology Program
www.geology.gov.yk.ca

DIAND Yukon Region
www.inac.gc.ca/regions/yt/index.html

Mining Recorder
www.gov.yk.ca/depts/dgs.miningrecorders

APPENDIX D. Contacts

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OTHER USEFUL CONTACTS

Whitehorse Mining Recorders Office
(claim sheets, mining legislation information)
Phone 667-3190
Fax 667-3267

Topographical map sales
Mac's Fireweed Books
Phone 668-6104
Toll-free 1-800-661-0508

Yukon Prospectors Association
Phone 668-7985
ypa@northland.com

Klondike Placer Miners Association
Phone 667-2267
Fax 668-7127

Yukon Chamber of Mines
Phone 667-2090
Fax 668-7127
ycmines@yukon.net
www.yukon.net/ycmines

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615 Booth Street
Ottawa, Ontario K1A 0E9
Phone 1-800-230-6275
napl@NRCan.bc.ca